

## **Exhibit 4**

# **SCHOOL DISTRICT/LOCAL GOVERNMENT ENTITY PLAINTIFFS' OPPOSITION TO DEFENDANTS' MOTION TO EXCLUDE TESTIMONY OF SCHOOL DISTRICT EXPERTS**

Case No.: 4:22-md-03047-YGR

MDL No. 3047

In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation

**EXPERT REPORT OF**  
**Dr. Ramin Mojtabai, M.D., Ph.D., MPH**  
**May 16, 2025**

The undersigned hereby certifies their understanding that they owe a primary and overriding duty of candor and professional integrity to help the Court on matters within their expertise and in all submissions to, or testimony before, the Court. The undersigned further certifies that their report and opinions are not being presented for any improper purpose, such as to harass, cause unnecessary delay, or needlessly increase the cost of litigation.

A handwritten signature in blue ink, appearing to read 'Ramin Mojtabai', is positioned above a horizontal line.

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Dr. Ramin Mojtabai, M.D., Ph.D., MPH

**TABLE OF CONTENTS**

	<b><u>Page</u></b>
1 EXECUTIVE SUMMARY .....	1
2 MY ROLE AND QUALIFICATIONS .....	2
2.1 Retainer .....	2
2.2 Education and employment.....	3
2.3 Research expertise .....	3
2.4 Knowledge of relevant study designs .....	4
2.5 Cause, multi-causality, contributing cause.....	5
2.6 Bradford Hill guidelines for causation.....	6
2.7 Reciprocal causation .....	8
2.8 Mediation, moderation, confounding.....	10
2.9 Use of questionnaires and ratings scales to assess mental health outcomes.....	11
2.10 Methodology of research and data used in answering the question.....	12
2.10.1 The “pyramid of evidence” .....	13
2.10.2 Why are there fewer experimental studies? .....	15
2.10.3 Meta-analyses as a lens .....	16
3 THE CONTEXT: TRENDS IN CHILD AND ADOLESCENT MENTAL HEALTH.....	17
3.1 Adolescents are not equally vulnerable to the adverse effects of social media ....	21
3.1.1 Heredity and genetic risk .....	22
4 RESEARCH EXAMINING ASSOCIATION OF SOCIAL MEDIA USE WITH ADDICTIVE USE, DEPRESSION, SELF-HARM, BODY IMAGE DISSATISFACTION AND EATING DISORDERS .....	24
4.1 Social media use can lead to problematic or addictive use.....	24
4.1.1 What are the characteristics of problematic or addictive use?.....	24
4.2 The mechanisms of addictive use of social media are similar to those of drug addiction.....	26
4.3 Addictive use of social media is associated with other adverse outcomes .....	27
4.3.1 Industry’s research on addictive or problematic use.....	28
4.4 Problematic social media use is causally associated with depressive and anxiety symptoms .....	31
4.4.1 Meta-analyses support the link between social media use and depressive symptoms .....	32

**TABLE OF CONTENTS**  
**(continued)**

		<b><u>Page</u></b>
4.4.2	Evaluating the meta-analyses.....	35
4.4.3	Longitudinal studies support a causal association between problematic social media use and depressive symptoms .....	36
4.4.4	Experimental studies support a causal association between problematic social media use and depressive symptoms .....	40
4.4.5	Response to criticism that the association of social media use and depressive symptoms is small .....	43
4.5	Problematic use and unhealthy engagement with social media is associated with suicidal behavior .....	44
4.6	Problematic social media use is causally associated with negative social comparison and body image disturbance.....	45
4.6.1	Unhealthy use of social media may be related to body dysmorphic disorder and eating disorders .....	47
4.6.2	Meta-analyses support the causal association of social media use with body image dissatisfaction.....	48
4.6.3	Industry’s own research on social comparison and body image dissatisfaction.....	52
4.7	Social media use causes sleep disturbance .....	57
4.8	Youth with pre-existing mental health problems are especially vulnerable to adverse effects of social media .....	59
5	POTENTIALLY HARMFUL FEATURES OF SPECIFIC SOCIAL MEDIA PLATFORMS .....	61
5.1	The new image-based platforms are causally associated with body-image dissatisfaction.....	61
5.2	Algorithmic targeting is an important factor in the development of problematic use .....	62
5.3	TikTok, flow state and immersion .....	64
5.4	Addictiveness of TikTok .....	65
5.5	TikTok algorithm contributes to TikTok addiction .....	65
5.6	TikTok addiction leads to negative academic and mental health outcomes .....	66
5.7	TikTok “holidays” reduce mental health harms.....	67
5.8	TikTok use adversely impacts body image satisfaction.....	69
5.9	Experimental studies show a negative effect of TikTok on body image .....	70

**TABLE OF CONTENTS**  
**(continued)**

	<b><u>Page</u></b>
5.10 Excessive and problematic use of Instagram increases the risk of adverse mental health outcomes .....	71
5.11 The “dark side” of Snapchat .....	72
5.12 YouTube addiction .....	74
5.13 Conclusions from research on specific platforms .....	75
6 THE PANDEMIC ADVERSELY AFFECTED THE MENTAL HEALTH OF YOUNG PEOPLE .....	75
7 BOTH QUANTITY AND QUALITY OF SOCIAL MEDIA USE IMPACT MENTAL HEALTH .....	77
8 RESEARCH CONTESTING A CAUSAL LINK BETWEEN SOCIAL MEDIA AND MENTAL HEALTH .....	79
8.1 Orben and Przybylski’s reanalysis of survey data .....	79
8.2 Ferguson’s meta-analysis of experimental studies .....	81
9 SUMMARY OF RESEARCH .....	82
10 THE PLAUSIBILITY OF A CAUSAL ASSOCIATION .....	84
11 CONCLUSION .....	87
12 REFERENCES .....	89

## 1 EXECUTIVE SUMMARY

1. In this report I address the question whether problematic use of social media can cause or contribute to the development of mental health problems in youth, including depression and depressive symptoms, suicidal ideations, body dissatisfaction and eating disorders. In section 5 of my report, I provide a review of the research done to date which includes a review of the evidence indicating that excessive use of social media can lead to addictive use of social media and is associated with increased risk of significant depressive symptoms, body image disturbance and other adverse mental health outcomes. I will address the methodology I use in undertaking this review, which consists of a systematic review of the literature, and in one instance, conducting a secondary meta-analysis. As a preamble, I provide a discussion of the concept of “contributing cause” and the commonly used guidelines proposed by the British researcher and epidemiologist Sir Austin Bradford Hill.
2. There are currently several social media platforms used by adolescents. Although they each have specific features, there are many commonalities among these platforms, which justifies examining their effects as group. First, there are significant similarities across different social media platforms with regard to design and features which use reward reinforcement mechanisms discussed later. Second, research on the mechanisms linking excessive social media use with mental health outcomes has uncovered some of the same mechanisms, including immersive use, social rewards, social comparison of appearance and lifestyle and fear of missing out (FOMO). In later sections of this report, I will discuss these mechanisms in more detail. Third, most users of social media use multiple platforms. For example, a recent survey of Canadian teens found that 58% used two or more social media platforms.<sup>1</sup> Nevertheless, there is some literature on the specific features of individual platforms. In section 6 of my report, I provide a selective review of some of these distinctive features for specific social media platforms that have received attention as being especially harmful.
3. In section 7, I briefly discuss research on the association of social media use with adverse mental health outcomes during the COVID-19 pandemic. There is much evidence that COVID-19 pandemic was associated both with increased mental health problems among adolescents and young adults as well as increased use of social media.
4. In section 10, I provide a summary of the research on the association between use of social media and mental health problems and summarize the salient themes and findings of this research as well as my opinion on the plausibility of a causal connection between problematic social media use and addiction and other mental health harms.
5. My opinions are provided to a reasonable degree of medical and scientific certainty. In formulating my opinions, I considered relevant available literature, documents produced

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<sup>1</sup> <https://mediaincanada.com/2021/08/13/tiktok-is-the-most-popular-social-app-with-canadas-youth/>).

by defendants and my knowledge and experience as an expert in the fields of psychology, epidemiology and psychiatry.

6. My *Summary of Opinions* is as follows:

- A. Problematic social media use and social media addiction are substantial contributing causes of adverse mental health outcomes, including depressive and anxiety symptoms, body image disturbance, eating disorders, and suicidality, in children, adolescents, and young people.
- B. Children, adolescents, and young people are more vulnerable to problematic social media use and addiction than adults. Individuals with pre-existing mental health problems are especially vulnerable to harms resulting from social media use.
- C. Multiple features built into the design of social media platforms are conducive to their excessive and problematic use by youth, and these features increase the risk of addictive use of the app and other adverse mental health outcomes. These include “incentive salience” (highly pleasurable stimuli such as receiving “likes” or positive comments on posts), the “immersive” nature of these media, and the “algorithmic” nature of some of the social media apps.
- D. Both a greater degree of exposure to social media platforms and the nature of the use (e.g., addictive use, social comparison, FOMO) contribute to the adverse mental health effects of social media in children and adolescents.
- E. Problematic social media use causes adverse mental health outcomes in children and adolescents in part by fomenting negative social comparison and sleep problems.
- F. Given the ubiquity of social media use and the large amount of time that youth spend on these media at the cost of other activities, the population burden of associated mental health problems is significant.

7. My opinions, and the bases for them, are discussed in greater detail in the report below. I reserve the right to revise, amend or supplement these opinions if additional relevant information becomes available.

## 2 MY ROLE AND QUALIFICATIONS

### 2.1 Retainer

8. I have been retained by counsel to prepare an expert report on what relationship there is, if any, between social media use and adverse mental health outcomes in adolescents and youth. In forming my opinions, I have relied upon the following sources of information: my education, my knowledge and background as an expert in the fields of psychiatry, psychology, medicine and epidemiology, my research expertise and my research

specifically related to the association of social media use and social media addiction with child and adolescent mental health problems.

9. My rates and prior history of testimony are attached to this report as Exhibit A.

## 2.2 Education and employment

10. I am a Professor and Vice Chair of Research at the Department of Psychiatry and Behavioral Sciences of Tulane University School of Medicine in New Orleans, Louisiana. As part of my job as a professor, I mentor junior faculty and teach residents of psychiatry. I am also a licensed physician with Board Certification by the American Board of Psychiatry and Neurology. I graduated from the Tehran University of Medical Sciences in Iran and completed an Internship and Residency in Psychiatry at Beth Israel Medical Center in New York City after completing the United States Medical Licensure Examination (USMLE). In addition, I completed a PhD in Clinical Psychology at the University of Tulsa in Oklahoma along with an Internship in Clinical Psychology at George Washington University Medical Center in Washington, DC. I also completed a Research Fellowship at the Department of Psychiatry of Columbia University in New York and have a Master's of Public Health (MPH) degree from Columbia University. My MPH training involved coursework in Epidemiology and Biostatistics, as well as courses examining the social and environmental causes of behavioral and physical health conditions.
11. Previous to joining Tulane University, I was a Professor at the Bloomberg School of Public Health and Department of Psychiatry and Behavioral Science at Johns Hopkins University. I also had a clinical practice at the Community Psychiatry Program of Johns Hopkins Hospital where I treated adult patients with a broad range of mental health problems including depression, anxiety and stress-related mental health crises.
12. My CV is attached to this report as Exhibit B.

## 2.3 Research expertise

13. My research expertise is in behavioral health services as well as psychiatric epidemiology and outcomes research. My behavioral health services research has examined the impact of different policies, including the US Affordable Care Act implemented in 2014, on the use of behavioral health services. I have also examined the patterns and time trends in mental health problems in the US and in other countries. I have been a prolific researcher with 338 publications listed in PubMed that have garnered over 26,000 Google Scholar citations and an H-Index of 82, meaning that 82 of my papers have been cited at least 82 times each.
14. My research has been published in high impact journals such as the *New England Journal of Medicine*, *American Journal of Epidemiology*, *Social Psychiatry and Psychiatric Epidemiology*, *Epidemiology and Psychiatric Sciences*, *JAMA Psychiatry*, *Pediatrics* and *American Journal of Public Health*, among others. I have also led or co-led nine R01 grants, one R34 grant and a Mentored Scientist Research Award (K01) from the US National Institute of Health and several other grants from private foundations and the pharmaceutical industry, totaling millions of dollars.



15. I have served as a reviewer of grants for several agencies, including the US National Institute of Health (NIH), and I was most recently a standing member of the Community Influences on Health Behaviors (CIHB) Study Section of NIH for four years. I have also served as reviewer for or on the editorial board of a number of journals including the editorial board of *Psychiatric Services*, one of American Psychiatric Association's (APA) journals.
16. I am currently a member of the Writing Group of Practice Guidelines of APA. The APA Guidelines for Treatment of Patients with Schizophrenia and Guidelines for Treatment of Patients with Borderline Personality Disorder have been published. These guidelines are meant to provide an updated knowledge base and direction for practicing mental health professionals in management of psychiatric problems.

#### 2.4 Knowledge of relevant study designs

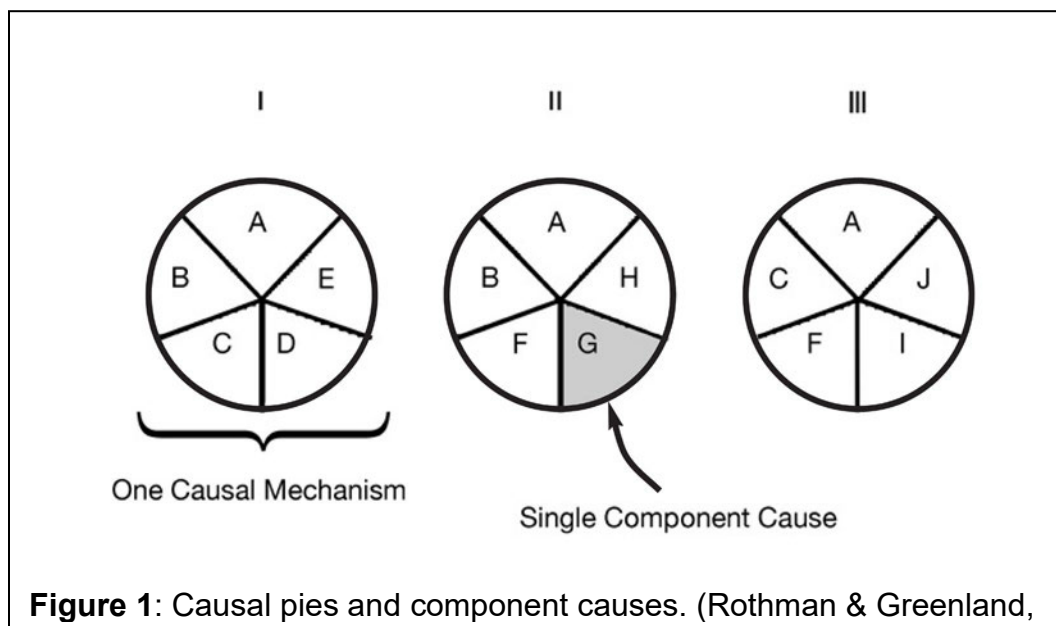
17. Through my training and 3-decades of experience as a researcher, I have gained a deep understanding of how epidemiological research is conducted, what types of valid conclusions can be drawn from this research and what limitations must be considered in analyzing these studies and drawing causal conclusions from them. This experience is gained through leading or collaborating on virtually hundreds of cross-sectional and longitudinal studies.
18. I have also used methods to draw causal inference from observational studies such as use of instrumental variables, statistical methods that emulate experimental studies (Mojtabai 2011a, 2011b) and collaborated or led studies implementing and/or analyzing data from randomized controlled trials (Susukida et al. 2018; Nakimuli-Mpungu et al. 2019; Sharifi et al. 2019; Amin-Esmaili et al. 2021; Susukida et al. 2021; Ackerman et al. 2019; Mojtabai et al. 2024). I have also conducted or supervised studies directly examining the association of social media with mental health problems in adolescents (Riehm et al. 2019; Mojtabai 2024).
19. Almost all of the primary studies reviewed in this report are cross-sectional, longitudinal or experimental studies. In reviewing this literature, I also draw on my experience in conducting such studies and acting as a peer-reviewer for hundreds of studies submitted for publications to scientific journals (including studies of the health effects of social media), and my experience reviewing research grant applications for the NIH and other funding agencies.
20. Part of the research I reviewed for the present report was based on meta-analyses of primary research. I have led or collaborated on a number of meta-analyses that have examined the role of psychosocial treatment in management of schizophrenia, compared behavioral therapy and antidepressant medication for treatment of obsessive-compulsive disorder, compared different medication treatments for stimulant use disorder, and assessed effects of illness chronicity on the structure of symptoms in schizophrenia. Although none of these meta-analytic reviews focused on the studies of the association between social media use and mental health outcomes, the methodology for selecting primary studies to be included

in the meta-analysis, producing quantitative summary measures of studies, testing for heterogeneity of effects, and assessing publication bias are similar among all meta-analytic studies. Furthermore, in my role as a peer reviewer for journals and funding agencies, I have had the opportunity to review numerous meta-analytic studies. As such, I have a deep understanding of how to judge the quality of such meta-analytic studies and how to interpret their results.

21. Overall, these experiences provide me with the expertise and knowledge to assess the merits and shortcomings of research linking social media use with adverse mental health outcomes.

## 2.5 Cause, multi-causality, contributing cause

22. The modern view of causation in epidemiology and medicine considers most outcomes resulting from a constellation of component causes or a “web of causation” (Krieger 1994). Further, the modern approach to causation takes into account the possibility of the same outcome having different causes, and also each causal mechanism having multiple components (Rothman and Greenland 1998; Rothman and Greenland 2005). These authors use the metaphor of pies to describe this model of multi-causality. Referring to the following figure (**Figure 1**). This figure presents 3 hypothetical cases of an illness (I, II, and III). The component causes of the illness in these cases are represented by letters A, B, C, D, E, F, G, I, J and F. The single component cause



23. highlighted (G) is part of the causal mechanism in case II, but not case I and III. Moreover, in every case, a combination of component causes contribute to the illness. For example, taking excessive use of social media as one of the component causes of depression, we would expect that this factor is not a component cause in many cases of depression and, in

cases where it is a component cause, other factors, such as genetic vulnerability, social adversity, family structure, metabolic factors, etc. are also contributing causes.

24. Rothman and Greenland further describe this model of causation in the context of necessary and sufficient causes:

“The importance of multicausality is that most identified causes are neither necessary nor sufficient to produce disease. Nevertheless, a cause need not be either necessary or sufficient for its removal to result in disease prevention. If a component cause that is neither necessary nor sufficient is blocked, a substantial amount of disease may be prevented. That the cause is not necessary implies that some disease may still occur after the cause is blocked, but a component cause will nevertheless be a necessary cause for some of the cases that occur.” S145 (Rothman and Greenland 2005).

25. This discussion raises another important aspect of causal associations in epidemiology—their probabilistic nature. For example, considering the link between smoking and cancer, we know that smokers do not always develop cancer (in fact only a minority do), and many of those who do develop cancer are non-smokers. Another important aspect of causal associations in epidemiology is that causes need to be examined in groups of people and apply to populations. To investigate a cause, we need to examine exposed and unexposed groups of people and to compare them with regard to health outcomes. Epidemiological evidence based on groups of people, such as those detailed in Bradford Hill’s guidelines that I discuss later, is needed to establish whether the putative causal factor increases the risk of the health outcome or disease we are considering (Freeman 2016).
26. These considerations are important in evaluating the possible role of social media as a cause or contributing cause of mental health problems. This view of causation accommodates vulnerabilities of children exposed to this potential risk factor, including their genetic or behavioral vulnerabilities. The critical questions are whether exposure to social media increases the risk for mental health problems and whether “blocking” the effect of social media could potentially reduce these outcomes.
27. Thus, finding that social media use is a contributing cause of mental health problems does not diminish the importance of other contributing causes, such as genetic and behavioral vulnerabilities, family factors, and large-scale social influences such as the lockdown during the COVID-19 pandemic. The multiplicity of causal factors also explains why some adolescents and young people are more likely to experience adverse health consequences as a result of exposure to social media than others.
28. In the next section I discuss how researchers have traditionally decided if an association is causal. I will specifically discuss a set of guidelines proposed by the British statistician and epidemiologist Sir Austin Bradford Hill. These criteria are commonly used by investigators to decide whether a relationship is likely causal in nature or not.

## 2.6 Bradford Hill guidelines for causation

29. It is commonly stated that correlation is not the same as causation. This is because many correlations are incidental or spurious. Some of the correlations are caused by other factors

and are thus “confounded”. But some correlations are indications of a causal relationship. There have been attempts over the years to come up with certain guidelines to decide whether a correlation is causal or not. While there are other accepted approaches, perhaps the most influential set of guidelines introduced for deciding on causality are those proposed by Austin Bradford Hill (Hill 1965). He regarded these guidelines as “aspects of the association” that should be considered before deciding that the association between two variables is causal—i.e., one variable caused the other. He refused to call these aspects of the relationship “criteria” for deciding causality, instead he called them “viewpoints” to emphasize that they should not be treated as hard and fast rules for establishing causality. In this section I briefly review these “viewpoints”. For simplicity of presentation, in the rest of this document I will refer to Bradford Hill’s viewpoints or aspects as “guidelines”, bearing in mind his warning that these are not hard-and-fast rules.

30. Below, I will briefly review these guidelines. Towards the end of this report, I will come back to them and critically examine the research findings regarding the possible causal link between social media use and mental health problems in light of these guidelines.

1) Strength of the association is the first aspect of the relationship that Hill suggested should be considered. Generally, the stronger the association the greater the possibility of a cause-effect relationship. However, Hill cautioned readers not to put too much emphasis on this aspect of association:

“We must not be too ready to dismiss a cause-and-effect hypothesis merely on the grounds that the observed association appears to be slight. There are many occasions in medicine when this is in truth so. Relatively few persons harbouring the meningococcus fall sick of meningococcal meningitis. Relatively few persons occupationally exposed to rat’s urine contract Weil’s disease [the bacterial infection leptospirosis]” (p. 8)

2) Consistency of the observed associations across different investigators, in different populations, in different places and circumstances was another of Hill’s guidelines. He used the example of the association of smoking with cancer of the lung that was recorded in 29 retrospective and 7 prospective studies by 1964. He also noted that similar confounding factors may influence studies with the same design and that he would put more weight on similar results reached by different methods (e.g., cross sectional and longitudinal studies).

3) Specificity of the association to specific groups of persons, particular locations and particular outcomes is another criterion for causation. However, Hill notes that many causes have multiple outcomes (e.g., smoking is associated with cancer of the lung and nose as well as cardiovascular disease). Clearly, some outcomes may have multiple causes as well.

4) Temporality is probably the oldest and best-known criterion for causality. It is impossible to imagine a causal relationship where the cause does not precede the outcome in time. However, Hill noted that establishing temporal order may be difficult for slowly developing outcomes. One of the examples he used is the association of diet with disease:

“Does a particular diet lead to disease or do the early stages of the disease lead to those peculiar dietetic habits?”

5) Dose-response relationship of cause and effect is also among the best-known guidelines of causal relationship. Again, Hill uses an example from cancer research—the dose-response relationship between the number of cigarettes smoked daily and corresponding risk of lung cancer. He also notes the difficulty in accurately measuring the “dose” of many types of exposures.

6) Plausibility of the underlying biological mechanism is perhaps the most elusive of Hill’s guidelines. Accordingly, he notes “this is a feature I am convinced we cannot demand”. This is because the scientific knowledge of the day may not be advanced enough to provide plausible mechanisms for cause-effect relationships. For example, John Snow established a cause-effect relationship between polluted water and cholera in the mid-1850’s without knowing the cause of cholera. Similarly, in the 18<sup>th</sup> century, Percival Pott established the cause-effect relationship between exposure to soot and scrotal cancer in chimney sweeps without knowing the biological mechanism underlying this association.

7) Coherence as another of Hill’s guidelines is related to the biological plausibility criterion as it requires that the “cause-and-effect interpretation of our data should not seriously conflict with the generally known facts of the natural history and biology of the disease.” Hill uses the example of association of temporal rise in smoking with lung cancer and with sex differences in mortality as supportive of the causal association of smoking with lung cancer.

8) Experiment is the criterion on which Hill put the most emphasis in his list of guidelines. In his words, where preventive action is possible and it leads to change in outcome, “here the strongest support for the causation hypothesis may be revealed”.

9) Analogy is among the least well-characterized of Hill’s guidelines. In this context analogy means that evidence of one causal relationship would strengthen the causal argument for another similar risk factor. Here, he uses the example of congenital harms associated with exposure to thalidomide and rubella in pregnancy. Having these examples in mind, we are more ready to accept evidence for harm caused by another drug or virus in pregnancy.

31. In considering these guidelines, it is important to keep in mind Hill’s emphasis that we should not consider them as hard-and-fast rules but as things to consider to “help us to make up our minds on the fundamental question—is there any other way of explaining the set of facts before us, is there any other answer equally, or more likely than cause and effect?”

## 2.7 Reciprocal causation

32. A concern raised in determining causality in general, and here by critics of research on the association of social media with future mental health problems, is reciprocal relationships (Orben, Dienlin, and Przybylski 2019; Odgers and Jensen 2020). These critics point to evidence from longitudinal studies that show that individuals with mental health problems

are more likely to use social media when assessed later (Heffer et al. 2019). This is a not uncommon criticism of causal claims based on cross-sectional data. Unless a variable is “unambiguously exogenous”, one cannot say that this variable is the cause of another with certainty. Some unambiguously exogenous variables are sex, age and race-ethnicity. If we find that a health outcome is related to these variables even in a cross-sectional study, we can say with confidence that these variables are causal. For example, finding that female adolescents are more likely to experience depressive symptoms, we know that the direction of causal effect is from sex to depressive symptoms. We know that depressive symptoms cannot change the person’s sex. In this case, sex is an “exogenous” variable. Similarly, there is strong evidence from cross-sectional studies that advanced age is associated with dementia. We know that dementia cannot be a cause of calendar age because calendar age is “exogenous”. Only passage of time can “cause” age.

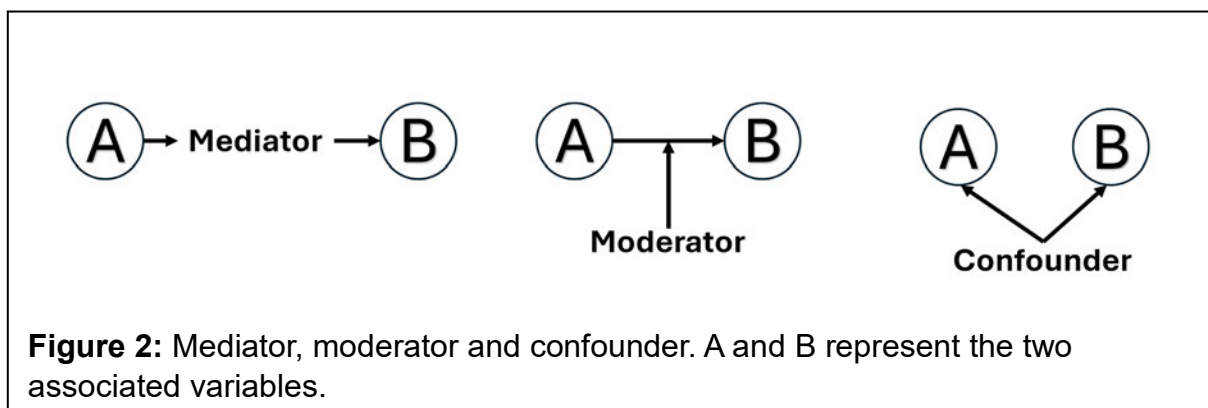
33. On the other hand, the direction of causation in cross-sectional studies showing an association between depressive symptoms with dementia is ambiguous—depression could be a contributing cause of dementia, or dementia could be a contributing cause of depressive symptom. A third possibility is a “reciprocal” causal relationship between the two. A reciprocal causation can arise if in some people depression increases the risk of future dementia and in another group of people, dementia increases the risk of future depression. Alternatively, it can be the case that having more depressive symptoms increases the risk of dementia or severity of dementia symptoms which in turn aggravate the depressive symptoms and this reciprocal process gives rise to a vicious circle.
34. Longitudinal and experimental studies can go a long way in resolving the question of reciprocal causation as well as showing the direction of causal associations in non-reciprocal causal associations. These study designs take advantage of the temporal order of cause and effect that I discussed among Hill’s guidelines for causation. For example, longitudinal studies showing that people with depression are more likely to develop dementia later in life are supportive of the conclusion that the direction of causal relationship is from depression to dementia. Some longitudinal studies support this (Gerritsen et al. 2022; Hu et al. 2024). On the other hand, studies may show a reciprocal or bidirectional association, as indeed some other research has shown this reciprocal relationship (Liu et al. 2023). Experimental studies can also be used to assess direction of causation. Further using the example of depression and dementia, the effect of treatment of depression on future risk of dementia or treatment of dementia on future depression can be examined (Dafsari and Jessen 2020; Bartels et al. 2018).
35. As I will discuss in future sections, a number of past longitudinal studies of social media and mental health outcomes have examined reciprocal associations (Chang et al. 2022; Frison and Eggermont 2017). It should be noted that evidence of reciprocal associations does not annul a causal relationship. If it is shown that people with mental health problems are more likely to use social media and, at the same time, that people who use social media excessively are at increased risk of adverse mental health outcomes, the latter causal relationship is still a valid relationship.
36. For example, a recent study involving 479 adolescents with the average age of 16 found that depressed adolescents did not differ from their non-depressed peers in the frequency of social media postings and the time spent scrolling (Janssen et al. 2025). However, in



daily assessments conducted for the next 100 days, depressed adolescents reported feeling twice as insecure after scrolling, nearly twice as rejected during online communication with friends, and significantly more preoccupied with feedback they received. The study did not investigate the link between social media use patterns in the years before the study. It is quite possible that these adolescent's experiences with social media had contributed to their becoming depressed to begin with.

## 2.8 Mediation, moderation, confounding

37. In examining causation, three related concepts should be considered: mediation, moderation and confounding. Mediation happens when a third variable exists between the cause and effect. Examining mediation reveals the mechanisms through which a causal factor produces its effect. So, we can consider the mediator as a factor that explains how an exposure mechanistically results in the outcome. For example, smoking cigarettes results in an increase in lung cancer, where exposure to carcinogens is the mediator. A body of social media research has examined whether upward social comparison is a mediator between excessive social media use and adverse mental health outcomes (Yoon et al. 2019; Irmer and Schmiedek 2023). In upward social comparison the user envies others portrayed on social media or considers their achievements higher than his or her own.
38. In contrast, a moderator is a variable that changes the relationship between the cause and effect. For example, sex may be a moderator of the association of social media use and mental health outcomes. In this case, age is a moderator of the association of social media use and mental health outcomes.
39. In contrast to both mediators and moderators, confounders are variables that are causally related to both the putative cause and outcomes and create the impression that these two variables are causally related. For example, much research has shown that girls are more likely to have depressive symptoms, and, at the same time, they are more likely to use social media. The relationship between social media and depressive symptoms, therefore, may be due to confounding by sex. Taking out the effect of sex in such a study by adjusting for sex will eliminate this potential confounding effect. **Figure 2** schematically depicts mediation, moderation and confounding. A and B in this Figure represent the two variables whose causal relationship we are interested in examining.



40. Distinguishing between some of these relationships is possible through the use of statistical methods. For example, using regression analysis, it is possible to distinguish between a mediator variable or a confounder, on the one hand, and a moderator variable. However, distinguishing between a confounder variable and a mediator is often based on theoretical knowledge, temporal order and common sense. Because a mediator is within the causal chain it cannot predate the cause. For example, sex cannot be a mediator of the relationship of social media use and mental health outcomes because it predates both (sex is assigned at birth). But it can be a confounder of the relationship between social media use and mental health outcomes.
41. Confounding is one of the major criticisms raised against cross-sectional studies that examined a relationship between social media use and mental health outcomes (Fumagalli, Shrum, and Lowrey 2024; Odgers and Jensen 2020). For example, some research suggests that the rise in adolescent depressive and anxiety symptoms in recent years may be due to change in the young people's life-style changes (Buli et al. 2023). These life-style changes can potentially be confounders of the association of social media use with adverse mental health outcomes. Longitudinal and experimental studies are less prone to confounding and can be relied upon to address this criticism.

## 2.9 Use of questionnaires and ratings scales to assess mental health outcomes

42. Research in many medical fields relies on both objectively assessed measures (e.g., blood pressure, blood glucose, EKG) and subjectively experienced and reported measures (e.g., pain, dizziness). However, psychiatry and psychology research almost exclusively rely on self-reported subjective measures to ascertain mental health outcomes because few mental health outcomes can be assessed objectively. The clinical diagnostic assessment in psychiatry also mainly relies on self-reported measures (e.g., sadness, anxiety, paranoia, fearing of gaining weight, impairment in functioning) to ascertain existence of psychiatric disorders such as Diagnostic and Statistical Manual's (DSM) major depressive disorder, generalized anxiety disorders, and eating disorders.
43. Because mental health clinicians commonly disagree about the significance of symptoms, researchers in mental health have developed standardized measures and questionnaires to improve consistency of such assessments (Aboraya et al. 2006). These measures are more reliable than clinician assessments. In this context, reliability means that different researchers can obtain the same or very similar ratings when assessing the same subject or when assessing the subject over a short period of time.
44. Standardized questionnaires and rating scales improve the reliability of assessments as they do not rely on interviewers' judgement. Many of these questionnaires are designed to replicate the criteria for specific diagnostic categories (e.g., PHQ-9 and GAD-7 replicate the diagnostic criteria for DSM-5 major depressive disorder and generalized anxiety disorder, respectively). These self-report questionnaires are either filled out by the subjects themselves or completed by researchers who ask standard questions verbatim as written in the questionnaire. These questionnaires have been validated by comparing their ratings with the diagnoses made by clinicians or by comparing their results with other measures of the same condition (e.g., comparing two rating scales of depression). Validation in this context means ensuring that the questionnaire measures what it is supposed to measure.



For example, if a questionnaire of depression agrees with the clinicians' diagnoses of major depressive disorder or with another measure of depression, this provides evidence in support of the validity of that measure.

45. Established questionnaires correspond remarkably with research diagnoses made by experienced clinicians. For example, in a validation study of PHQ-9, while 17 of 19 (89%) of those with PHQ-9 score >20 met diagnostic criteria for a depressive disorder, only 9 out of 357 (3%) with a PHQ-9 score of <5 met these criteria (Kroenke, Spitzer, and Williams 2001). The clinical diagnoses in this study were based on semi-structured interviews by clinicians which is a gold standard in most validation studies.
46. Another advantage of using questionnaires and ratings scales is that these measures can capture subthreshold conditions. These are cases with less severe or fewer symptoms that do not arise to the diagnostic threshold for a disorder but are still associated with significant impairment in functioning and psychological distress and, because they are more prevalent than disorders that meet the diagnostic criteria, present a significant public health challenge (Roberts et al. 2015).
47. The ability to obtain quantitative measures of psychopathology from questionnaires and rating scales provides a distinctive advantage for research studies as analyses based on these quantitative measures are typically more powerful (Ragland 1992). This means that smaller causal effects are more readily captured. Furthermore, the quantitative differences in scale scores are closely tied to the prevalence of extreme values and cut-offs, a point made decades ago by the prominent epidemiologist Geoffrey Rose. In a 1990 paper titled "The population mean predicts the number of deviant individuals", Drs. Rose and Day (Rose and Day 1990) identified very strong correlations between a number of categorical health outcomes (such as hypertension) and the distribution of the underlying continuous health outcomes (such as high blood pressure). They wrote:
 

"If we want to discover the causes of hypertension, obesity, alcoholism, depression, violence, and so on we need to study the determinants of average blood pressure and weight, average alcohol intake, average population "mood," intellectual performance, aggression, etc." (p. 1034)
48. Lastly, research has consistently shown that continuous measures of psychopathology that are obtained from rating scales and questionnaires are more reliable and valid than dichotomous measures (Markon, Chmielewski, and Miller 2011). As such, the use of questionnaires and rating scales for assessment of mental health outcomes of social media use is a strength of this body of research.

## 2.10 Methodology of research and data used in answering the question

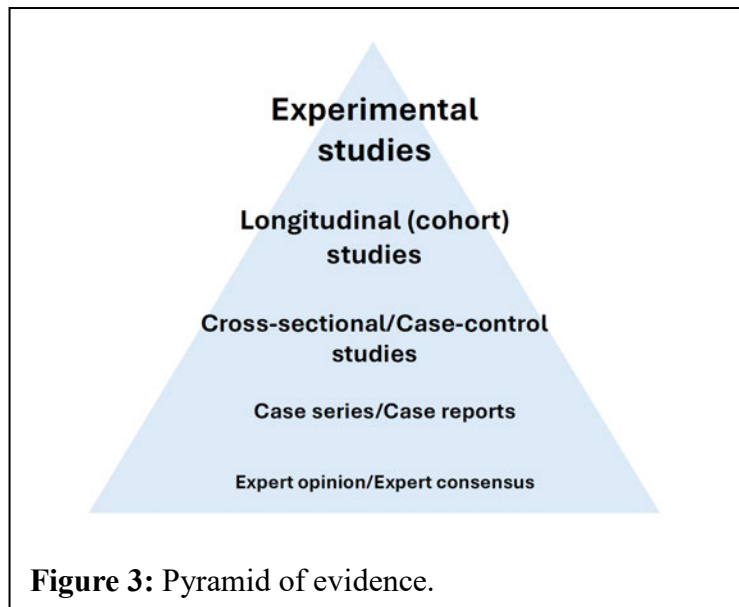
49. To assess the evidence for a causal link between social media use and adverse mental health outcomes, I used the same methods I use in my research and clinical practice and applied these methods with the same rigor.
50. For preparing this report, I conducted a systematic review of literature using the Google Scholar and PubMed databases using the following terms: "social media" OR "social

networking” OR “problematic social media use” OR “Facebook” OR “Instagram” OR “TikTok” OR “Snap” OR “YouTube” OR “WhatsApp” OR “Twitter” AND “depressive” OR “anxiety” OR “depression” OR “internalizing” OR “body image” OR “eating disorder” OR “suicide” OR “self-harm” OR “sleep” OR “social comparison” . I examined the titles and abstracts of the resulting searches and obtained the papers that specifically examined the association of social media use (or problematic use) with the mental health outcomes. I also examined the reference section of the obtained papers for other relevant reports that may have been missed in the search.

51. In addition, I reviewed numerous meta-analyses and primary studies including cross-sectional, longitudinal, and experimental studies that examined the association between various aspects of social media use (e.g., number of hours of use, frequency of use, problematic or addictive use) and associated harms, including anxiety, insomnia, significant depressive symptoms/disorder, suicidal ideations, eating disorders and body image disturbance. I also reviewed studies examining the prevalence of excessive or problematic social media use and addiction. I read numerous review articles as well as opinion pieces by experts in the field. In one case, I also conducted a secondary meta-analysis to examine the association between excessive social media use and body image disturbance in primary studies of adolescents. This report contains my overview of this literature and my further analyses. A list of my Materials Considered is attached to this report as Exhibit C.
52. In reviewing the evidence, I also paid close attention to the level of confidence that one can reasonably have in each study’s findings based on the potential effect of confounding. Findings from different research designs do not provide the same level of confidence. For instance, editorials and case series are much more likely to be influenced by the researchers’ biases. Whereas, findings from randomized experimental studies are least likely be biased because the treatments are assigned on a random basis.
53. After a review of the evidence, I apply a Bradford Hill analysis, as described above, to determine whether the association between social media use in children and adolescents and mental health problems is causal.

#### 2.10.1 The “pyramid of evidence”

54. Researchers generally agree on a ranking of research designs based on the vulnerability of these designs to confounding. This ranking is often represented as a pyramid of evidence (**Figure 3**) in which the evidence that is most prone to confounding and thus is potentially biased is at the bottom of the pyramid. This includes expert opinion and consensus among experts. Case reports and case series in which investigators present the history of one or more individuals occupy a higher level of the pyramid. In addition to being vulnerable to the researchers' opinions, these studies are prone to selective reporting. Investigators with certain biased opinions may selectively choose and report on cases that support their opinions.



55. Cross-sectional and case-control studies occupy a higher level. Cross-sectional studies measure two or more variables at one time point (as if a cross-section of a dynamic process is taken) and examine the association of these variables at that one time point. A major limitation of this study design is that it is difficult to establish cause and effect relationships. If A and B are related in a cross-sectional study, it is equally possible that A causes B, B causes A, or the relationship is reciprocal. Another limitation of these studies is that any association between the two variables may be related to a third variable that is not captured in the study. For example, the relationship of social media use with depressive symptoms may be related to poor peer relationships. Children with poor relationships with their peers are prone to experience depressive symptoms (McFarlane, Bellissimo, and Norman 1995). These children may also prefer spending time on social media rather than having in-person interactions with their peers. In this case, social media use and depressive symptoms may appear to be related, but their association is confounded by a third factor, i.e., poor peer relationships.

56. Case-control studies are also cross-sectional in nature, but they assess exposures that pre-date the outcome. For example, a case-control study of the association of social media use with depressive symptoms may choose two groups of adolescents, one with depressive symptoms and another, without such symptoms and assess their social media use history. This design is similarly prone to biases due to confounding mainly because people are generally not good at accurately recalling past events and temporal order of past experiences.

57. Longitudinal or cohort studies are less prone to confounding as they examine the association of an exposure, such as social media use, with an outcome, such as depressive symptoms, at a later time. Participants in such studies are followed up and assessed 2 or more times in the course of the study. This allows researchers to exclude the possibility of

confounding by known factors because they can be assessed at baseline. Going back to the previous example, the researchers may be able to assess and exclude adolescents with poor peer relationship at baseline or “adjust for” peer relationship in their statistical analysis. Statistical adjustment removes the effect of the adjusted variable from the relationship of exposure and outcome. However, longitudinal or cohort studies are still prone to confounding by unmeasured factors. For example, adolescents who use social media excessively or in an unhealthy way may be different from other adolescents in ways that are not known to the investigators and not measured in the study and these unknown or unmeasured factors may also be the cause of future depressive symptoms. This sort of confounding by unknown or unmeasured variables is not easy to detect simply because the confounders are unknown or unmeasured.

58. Nevertheless, a major advantage of longitudinal studies is that they allow researchers to examine the temporal order of events which is one of the Hill guidelines for causal associations. However, they are more costly and labor intensive and maintaining participants in these studies over time is sometimes challenging.
59. Both cross-sectional and longitudinal studies are considered “observational” studies in that participants’ behavior is observed and the researchers do not intentionally introduce a change in participants’ lives. These studies are in contrast with experimental studies where the researchers intervene by introducing a new exposure (e.g., a specific type of social media) or remove an exposure (e.g., restrict number of hours of social media use). Relatively fewer studies have used an experimental design to examine the association between social media use and mental health problems.
60. Randomized experiments are generally known by researchers as the “gold standard” for establishing causation. This is because participants are randomly assigned to the experimental arm or control arm and hence the effect of confounding factors and reverse (i.e., reciprocal) causation is removed.
61. Controlled trials or experimental studies are generally immune to confounding to both known and unknown variables because participants are assigned to either the experimental arm (exposure) or the control arm that is unexposed. For example, if adolescents could be randomly assigned either to an experimental arm of using social media for long periods of time every day or a control arm in which they do not use any social media and these groups could then be compared at a future time point with regard to the development of mental health problems, the effect of any potentially confounding factors on the association of social media use and development of mental health problems could be removed because individuals are randomly assigned to the study arms. This is an important advantage of experimental studies and why Bradford Hill assigned such a high standing to evidence from experimental studies among his causal guidelines.

#### 2.10.2 Why are there fewer experimental studies?

62. While experimental design is often referred to as the gold standard for establishing a causal relationship, it is often more difficult to implement it in the real world. This is especially the case when the intervention involves a drastic departure from the participants’ routine daily activities. The use of social media is so ubiquitous and pervasive that it is impractical

to randomly assign participants to not use these apps for a long time. It is hard to imagine an adolescent who would agree to not using social media apps in his or her daily life for weeks or months on end. Furthermore, this intervention may disrupt social activities of many adolescents who depend on social media platforms to communicate and socialize with their peers or to fulfill academic requirements, raising ethical concerns.

63. As a compromise, investigators often settle on randomizing their study participants to an experimental arm of restricted use of social media (e.g., use limited to 1 hour per day) or brief social media holidays and a control arm of the usual pattern of use for control participants. In this experimental design, rather than introducing the possibly harmful agent in a randomized manner, limited exposure to this potentially harmful agent is randomized.
64. In another type of experimental study, participants are randomized to an experimental arm exposed to a specific social media content or algorithm that is designed to induce transient negative feelings. For example, participants may be exposed to content that is designed to induce upward social comparison (McComb, Vanman, and Tobin 2023). Ethical issues aside, this would require access to manipulation of algorithms, to which the public does not have, nor does it have access to internal studies where this was done. On the other hand, Facebook had a process for implementing experiments on users, “launching” them (a process that was set forth in a 30-Minute Experimentation Flow Guide (META3047MDL-204-00010152-00010167)).

### 2.10.3 Meta-analyses as a lens

65. A fourth type of research design is meta-analysis, in which the quantitative results from several cross-sectional, longitudinal, or experimental studies are combined. One advantage of meta-analyses over individual studies is that because of the larger number of subjects across individual primary studies, meta-analytic studies are more likely to find significant results when the magnitude of association is small. Another advantage of meta-analysis is that it allows researchers to examine consistency of effects across settings. Because individual studies are conducted with different groups of participants, often at different settings and by different investigators, showing consistent results across studies adds confidence that the association is real and is not an incidental finding. Thus, meta-analyses provide support for Hill’s criterion of “consistency” described earlier.
66. Nevertheless, there are potential limitations that should be considered in examining the results of meta-analytic reviews. A major potential limitation is publication bias where primary studies with larger effect sizes and statistically significant results or with larger sample sizes get published and included in the meta-analyses, and studies that fail to find significant results because of small effect size or small sample size are simply filed away and never published and, as a result, have no chance of being included in the meta-analyses. This problem can lead to inflated estimates of the results in meta-analyses (i.e., larger effect sizes than is true in the population). For example, if the true size of the correlation between excessive social media use and depressive symptoms is  $r=0.12$  and only studies that found a correlation of  $r=0.20$  or larger or studies that found statistically significant results get published, whereas studies with smaller correlation sizes and statistically non-significant results are not published, then a meta-analysis of these primary studies will find a correlation larger than  $r=0.12$ .

67. There are statistical methods that allow researchers to examine publication bias in a meta-analysis by assessing whether there is an association between the effect size (e.g., the magnitude of correlation coefficient) and the sample size in primary studies included. An association between these two suggests that primary studies with larger sample sizes were preferentially published and included in the meta-analysis, whereas primary studies with smaller sample sizes and smaller effect sizes were filed away and not included. As I will note below when discussing meta-analytic studies, most meta-analyses of the association of social media use with mental health outcomes did not detect any publication bias, possibly because this is a highly topical issue and most research in this area is ultimately published and included in meta-analytic reviews.

68. While in classic versions of the pyramid of evidence meta-analyses of experimental studies were placed at the top of pyramid, with the expanded use of meta-analytic methods to quantitatively summarize cross-sectional and longitudinal studies as well as experimental studies, the place of meta-analyses in the pyramid needs reconsideration (Murad et al. 2016). A meta-analysis of case-series cannot provide the same degree of confidence as a meta-analysis of well-conducted randomized trials. Instead of placing all meta-analyses at the top of the pyramid, meta-analyses can be viewed as

“...a lens through which other types of studies should be seen (i.e., appraised and applied). The systematic review (the process of selecting the studies) and meta-analysis (the statistical aggregation that produces a single effect size) are tools to consume and apply the evidence by stakeholders. (Murad et al. 2016)

69. In reviewing the evidence for the causal association of social media use with adverse mental health problems, I considered where in the pyramid of evidence the research studies could be placed. I also considered whether the associations reported could be the result of confounding factors and to address this, where available, gave precedence to findings from longitudinal and experimental studies that are less vulnerable to confounding as described below.

70. In reviewing the literature, I specifically examined the evidence of a causal link using Hill’s classic guidelines for establishing causal associations described above.

### 3 THE CONTEXT: TRENDS IN CHILD AND ADOLESCENT MENTAL HEALTH

71. There is growing evidence from both epidemiological and clinical studies that the prevalence of child and adolescent mental health problems is rising. The increase is especially prominent in depressive and anxiety symptoms as well as suicidal ideations and behavior. These concerns were reflected in the 2021 US Surgeon General Advisory, “Protecting Youth Mental Health” (Office of the Surgeon General 2021). The report notes:

“Unfortunately, in recent years, national surveys of youth have shown major increases in certain mental health symptoms, including depressive symptoms and suicidal ideation. From 2009 to 2019, the proportion of high school students reporting persistent feelings of sadness or hopelessness increased by 40%; the share



seriously considering attempting suicide increased by 36%; and the share creating a suicide plan increased by 44%.<sup>19</sup> Between 2011 and 2015, youth psychiatric visits to emergency departments for depression, anxiety, and behavioral challenges increased by 28%.<sup>20</sup> Between 2007 and 2018, suicide rates among youth ages 10-24 in the US increased by 57%.<sup>21</sup> Early estimates from the National Center for Health Statistics suggest there were tragically more than 6,600 deaths by suicide among the 10-24 age group in 2020.”

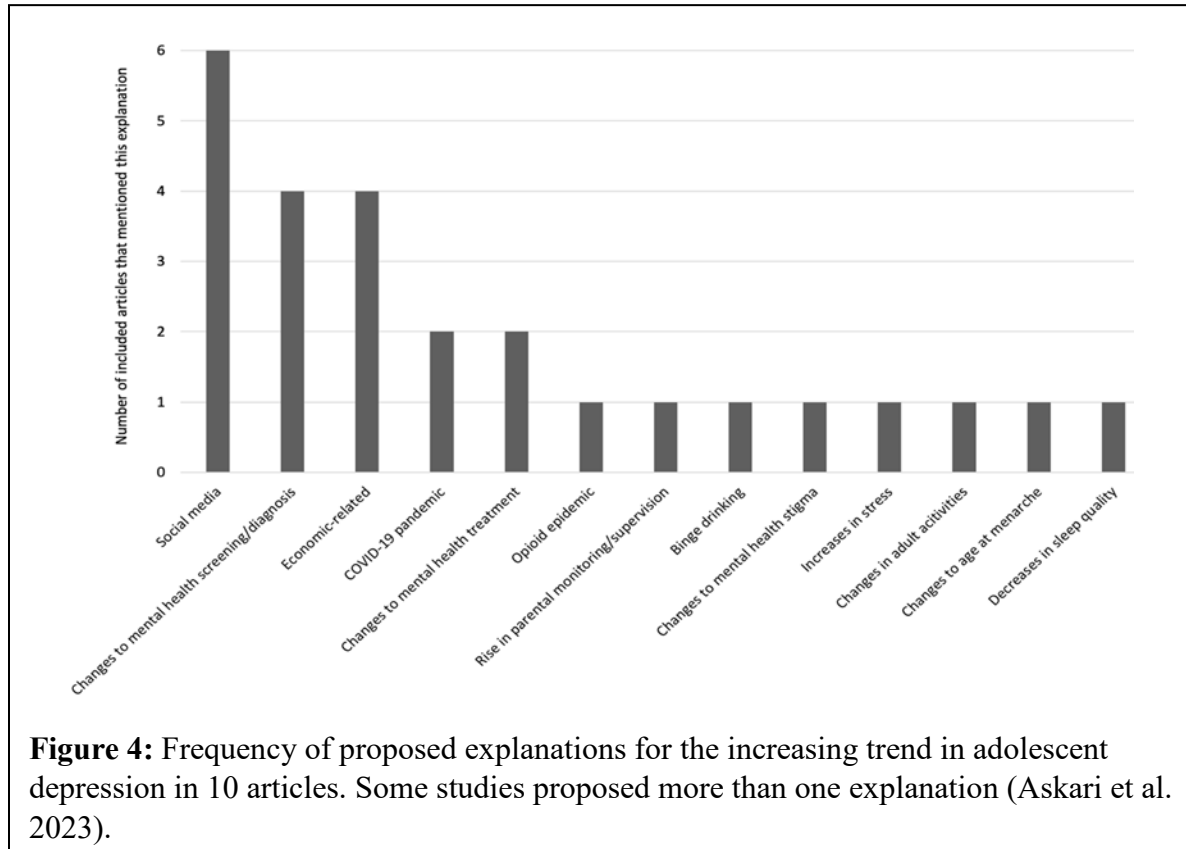
72. My colleagues and I were among the first research groups who reported on the increasing trend in adolescent major depressive disorder in the US (Mojtabai, Olfson, and Han 2016). Our study was based on data from the National Surveys on Drug Use and Health (NSDUH) which is a large-scale survey of the US general population conducted every year by the US Substance Abuse and Mental Health Services Administration (SAMHSA). We used data on 172,495 adolescents and 178,755 young adults who had participated in these surveys between 2005 and 2014. Using this data, we examined national trends in 12-month prevalence of major depressive episodes in adolescents (aged 12-17) and young adults (aged 18-25) overall and in different sociodemographic groups. Major depressive episodes were defined based on the criteria from the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) published by the American Psychiatric Association, which included 9 symptoms: (1) depressed mood, (2) loss of interest in usual activities, (3) recurrent thoughts of death or suicidal ideation, (4) changes in weight/appetite, (5) changes in sleep pattern, (6) slowing down in movement or speech, (7) fatigue or low energy, (8) difficulty in thinking/concentrating, and (9) feelings of worthlessness or excessive guilt. The diagnostic criteria are met when 5 or more of these symptoms are present for most of the days in a 2-week period (the criteria of major depressive disorder have not changed in the most recent version of the DSM, the DSM-5). The survey asked if the participant had experienced a period with these symptoms in the past 12 months (defined as the 12-month prevalence of a major depressive episode).
73. The study found that the 12-month prevalence of major depressive episodes meeting the above criteria increased from 8.7% in 2005 to 11.3% in 2014 in adolescents and from 8.8% to 9.6% in young adults, both at a highly statistically significant level— $p < .001$ . This significance level means that the likelihood of finding such trends just by chance is less than 1 in 1000. The trends remained statistically significant after adjustment for substance use disorders and sociodemographic factors, suggesting that they cannot be attributable to trends in demographic factors or substance use. Also, the trend was more prominent in adolescent girls (increase from 13.1% to 17.3%) compared to boys (increase from 4.5% to 5.7%), although the difference between girls and boys was not statistically significant. Studies by other research groups that have continued to obtain and analyze similar data in years after 2014 have continued to record an increasing trend up to 2020 (Goodwin et al. 2022; Daly 2022).
74. In another study also using the National Survey on Drug Use and Health, we used data on the use of mental health services to examine changes in different mental health problems and treatment settings over time (Mojtabai and Olfson 2020). This study included 230,070 adolescents surveyed between 2005 to 2018. While the overall prevalence of use of mental health services (for any type of mental health problems) in adolescents did not change appreciably over this period, internalizing problems, including suicidal ideation and

depressive symptoms, accounted for an increasing proportion of care (from 48.3% in 2005-2006 to 57.8% in 2017-2018;  $p < .001$ ), whereas externalizing problems (including “breaking rules and ‘acting out’,” “trouble controlling anger,” or getting into physical fights) accounted for a decreasing proportion (from 31.9% in 2005-2006 to 23.7% in 2017-2018;  $p < .001$ ).

75. The findings regarding externalizing disorders is consistent with other research on trends of these disorders (Kann et al. 2018). For example, prevalence of being in a physical fight among adolescents decreased from 43% to 24% between 1991 to 2017 and prevalence of alcohol use in decreased from 51% to 30% in this span of time (Kann et al. 2018).
76. One potential criticism of past studies that have shown increasing trends of child and adolescent depression and anxiety is that these studies are based on self-reports of affected children and adolescents who may have been more willing to disclose their mental health problems in more recent years (Jane Costello, Erkanli, and Angold 2006; Hermann et al. 2022). Indeed the Surgeon General’s Advisory also notes this possibility (Office of the Surgeon General 2021).
77. One way to address this criticism is to examine trends in diagnoses in clinical settings within the population of children and adolescents who are receiving care. If the proportion of children and adolescents with depression and anxiety within the population of help-seekers increased, the increase cannot be simply attributed to greater willingness to disclose one’s mental health problems. In a recent study, a colleague and I examined the proportion of different diagnoses made by clinicians within the population of children and adolescents receiving treatment in public mental health settings (Mojtabai and Olfson 2024). In this study which was based on over 1.7 million admissions each year between 2013 to 2021, the proportion of children and adolescents with anxiety disorder diagnoses more than doubled from 9.6% in 2013 to 19.2% in 2021 and the proportion with depressive disorder diagnoses increased from 13.4% to 17.0%. So, the increases in these conditions in more recent years is not only based on self-reported measures, but also based on clinicians’ diagnoses within the samples of children and adolescents who are seeking care.
78. The Surgeon General’s Advisory goes on to discuss several potential factors that may have been responsible for this increase, among them increasing academic pressure, limited access to mental health care, health risk behaviors such as alcohol and drug use, broader stressors such as the 2008 financial crisis, rising income inequality, racism, gun violence, climate change and growing use of social media. Among these factors, however, the growing use of social media has been the most pervasive. According to recent estimates published by the American Psychological Association, American adolescents spend an average of nearly 5 hours on social media daily (DeAngelis 2024). Most researchers agree that growth in use of social media is the most likely causal factor behind the increase in these mental health conditions.



79. In a paper that my colleagues and I published, studies between 1991 to 2022 examining trends in depressive disorders and symptoms among US adolescents were reviewed (Askari et al. 2023). We identified 10 such publications. The most common potential explanation for the rising trends in these 10 studies was the introduction and spread of social media use (**Figure 4**).



80. While the papers also discussed other potential causal factors for the rising trends, the timing of the trends in depression, starting around 2011-2012, most closely aligns with the increasing trend in use of social media. Other proposed causal factors either started decades earlier or in more recent years. For example, Gray and colleagues (Gray, Lancy, and Bjorklund 2023) proposed that a primary cause of the rise in child and adolescent mental disorders is a decline over decades in opportunities for children and teens to play, roam, and engage in other activities independent of direct oversight and control by adults. This process dates back to 1960's and the advent of TV. One recent potential risk factor, COVID-19, arose in early 2020's. A more recent US Surgeon General Advisory, titled "Social Media and Youth Mental Health" published in 2023 supported social media as a significant causal factor, highlighting many of the studies that I discuss in this report (Office of the Surgeon General 2023). The 2023 Advisory also points to potential biological mechanisms for the mental health harms of excessive or problematic social media use:

"Brain development is a critical factor to consider when assessing the risk for harm. Adolescents, ages 10 to 19, are undergoing a highly sensitive period of brain development.<sup>10, 11</sup> This is a period when risk-taking behaviors reach their peak,

when well-being experiences the greatest fluctuations, and when mental health challenges such as depression typically emerge.<sup>12,13,14</sup> Furthermore, in early adolescence, when identities and sense of self-worth are forming, brain development is especially susceptible to social pressures, peer opinions, and peer comparison.<sup>11,13</sup> Frequent social media use may be associated with distinct changes in the developing brain in the amygdala (important for emotional learning and behavior) and the prefrontal cortex (important for impulse control, emotional regulation, and moderating social behavior), and could increase sensitivity to social rewards and punishments.<sup>15,16</sup> As such, adolescents may experience heightened emotional sensitivity to the communicative and interactive nature of social media.<sup>16</sup>” (Office of the Surgeon General 2023)

81. In sum, a causal link between excessive and problematic use of social media and child and adolescent mental health problems is supported in the context of the rise in prevalence of these disorders among children and adolescents in parallel with the growth in the use of social media in this vulnerable age group.

### 3.1 Adolescents are not equally vulnerable to the adverse effects of social media

82. Research has identified differences in vulnerability of different groups of children and adolescents to the effects of social media. For example, a number of research studies have found that adolescent girls are more vulnerable to the negative effects of social media than boys, especially appearance-based social comparison (Nesi and Prinstein 2015; Liu et al. 2022).
83. Other research has identified individual factors that make some adolescents more vulnerable to the effect of social media exposure. For example, one study found that adolescents who are less popular among their peers may be more prone to engage in upward social comparison when viewing social media pages (Nesi and Prinstein 2015). In other studies, impulsivity, low self-esteem, and social anxiety were identified as predictors of social media addiction (Zhao et al. 2022; Vogel et al. 2014). As I will discuss in more detail later in this report, research also suggests that children and adolescents with pre-existing mental health problems are more vulnerable to the adverse mental health effects of social media (Kostyrka-Allchorne et al. 2023)
84. Nevertheless, due to the multicausal nature of mental health problems, identifying individual vulnerabilities to these problems does not negate the causal influence of excessive or problematic use of social media as a component cause. For every type of adverse health outcome and disease, there are always some individuals who are more vulnerable to causative factors and others who are less vulnerable. The most poignant example is the COVID-19 pandemic. While exposure to the virus was ubiquitous, not everyone exposed acquired the infection or presented the full-blown illness. Numerous individual and social vulnerability factors interacted with viral exposure to determine whether the individuals developed and succumbed to COVID-19 infection or experienced an asymptomatic infection.
85. The varied effects of social media on children and adolescents’ mental health was highlighted in the 2023 Advisory by the US Surgeon General, “Social Media and Youth

Mental Health,” where the Advisory notes that “..., different children and adolescents are affected by social media in different ways, based on their individual strengths and vulnerabilities, and based on cultural, historical, and socio-economic factors.” (Office of the Surgeon General 2023)

86. An important vulnerability factor is the young age of children who are exposed to social media. Several studies have shown that the association of excessive social media use with adverse mental health outcomes is stronger in younger than older adolescents (Mougharbel et al. 2023; Adeyanju et al. 2021; Tsitsika et al. 2014). For example, a study of 6,822 students (ages 11 to 20) from the 2019 Ontario Student Drug Use and Health Survey found that heavy use of social media (defined as 3 or more hours of use daily) was associated with doubling the odds of psychological distress measured using the commonly used K6 scale (Kessler et al. 2002). The association was not uniform across age groups: the odds ratios were 2.50 (corresponding to an  $r=0.25$ ) in students aged 11-14 and 1.45 ( $r=0.10$ ) in those aged 15 and over.
87. The effect of age, however, is not shown in all studies (e.g., Shannon et al. 2022). The discrepancy among studies regarding the moderating effect of age may be due to the fact that research studies do not typically assess age at initiation of heavy social media use—a factor that may be an important determinant of vulnerability. Furthermore, research by Orben and colleagues (Orben et al. 2022) on life satisfaction suggests that sensitivity to the effects of social media across childhood and adolescent years may be bimodal: higher social media use is associated with lower life satisfaction at ages 11–13 and again at age 19 years in females and at ages 14–15 and again 19 years in males. To my knowledge, whether a similar bimodal distribution in developmental sensitivities to social media exists for other outcomes, such as depressive symptoms, has not been investigated.

### 3.1.1 Heredity and genetic risk

88. Another set of potential causal factors for problematic social media use that have received some attention are heredity and genetic factors (Werling and Grünblatt 2022). While heredity studies examine the degree to which a behavior is inherited, usually through family or twin studies, genetic studies attempt to identify the specific genes responsible for inheritance of traits or diseases. Much of the genetic and heritability research on social media use is subsumed in the general body of research on problematic internet use or behavioral addictions. Because these disorders are quite broad and may involve different underlying mechanisms, little can be inferred from this body of research on heritability or genetic influences on problematic social media use specifically.
89. For example, a study of 5247 monozygotic (MZ) and dizygotic (DZ) adolescent twins registered with the Netherlands Twin Register, found that 48% of the individual differences in scores on the compulsive internet use scale (CIUS) were influenced by genetic factors (Vink et al. 2016). The remaining variance (52%) was due to environmental influences that were not shared between family members. However, the study did not examine heritability separately for different internet activities (e.g., gaming, chatting, skyping, social media use, etc.).

90. Another study that presumably sought to examine the heritability of intensity of social media use was based on the US MIDUS III study with twin participants having an average age of over 60 years (York 2017). However, the study asked about the frequency of connecting with family or friends through social media, not number of hours of social media use or problematic use of social media.
91. Similar to heritability studies, genetic studies also generally examined internet use as a group of activities and did not examine genetic influences in problematic social media use (Ryl et al. 2024). A recent exception is a Genome-Wide Association Study (GWAS) conducted in Norway—the Norwegian Mother, Father, and Child Cohort Study ( $n = 18,490$ ) (Frei et al. 2025). GWAS analyses examine the whole genome and look for polymorphisms that may be associated with specific traits. Single-nucleotide polymorphism (SNP)-based heritability of screen behaviors and the genetic correlations with six major psychiatric disorders (schizophrenia, bipolar disorder, major depressive disorder, autism spectrum disorder, attention-deficit hyperactivity disorder, alcohol use disorder), and educational attainment were examined in this study. Screen activities included 1) watching movies/series/TV; 2) playing games on PC, TV, tablet, mobile, etc.; 3) sitting/lying down with PC, mobile, or tablet (irrespective of activity); 4) communicating with friends on social media. For each activity, responses were coded from never/rarely to 7 hours or more. The heritability for social media use in this study was estimated as ( $h^2_{\text{SNP}}=0.12$ ), meaning that 12% of variance could be explained by SNPs, which is relatively low. The study identified four SNPs associated with the social media use phenotype. None were associated with a known neurochemical receptor or pathway. However, as the authors note, this is the first GWAS study of its kind and has not been replicated in any other samples. Furthermore, the study did not examine problematic use of social media or other screen activities. GWAS studies are notorious for finding relationships in one sample that cannot be replicated in other samples.
92. Another exception to genetic studies of internet use in general vs. specific to social media is a genetic association study conducted as part of the Psychological and Genetic Factors of Addictions study with 3,003 young Hungarians (mean age 21 years) that aimed to investigate genetic overlaps between different substance use, addictive, and other compulsive behaviors including social media addiction (Vereczkei et al. 2022). Social media addiction was measured by the Bergen scale. The study tested 32 SNPs chosen based on past genetic studies. While the study did identify associations between some SNPs and substance use disorders, none of the examined SNPs were associated with social media addiction.
93. In summary, there is scant research on heritability and genetic influences of problematic social media use specifically. Most of the available research focused on problematic internet use. Because problematic internet use is quite broad and includes a heterogeneous group of problematic behaviors it may very well involve different underlying mechanisms. As such, little can be discerned about heritability and genetic influences of problematic use of social media from research on problematic internet use. However, it is quite plausible that genetic influences contribute to vulnerability to problematic use of social media as in most other mental and physical health conditions.

94. For example, numerous genetic studies have examined genetic factors in post-traumatic stress disorder, a psychiatric disorder that is defined by exposure to life-threatening events (Nievergelt et al. 2019; Zai et al. 2022). For example, in one GWAS study, the heritability of PTSD among females was estimated as ( $h^2_{\text{SNP}} = 0.10$ ) (Nievergelt et al. 2019). This does not mean that PTSD is not caused by exposure to traumatic events—in fact, this is how the disorder is defined—but simply that certain people may be more vulnerable to PTSD when exposed to traumatic events. Additionally, genetics may play a role if an individual has pre-existing co-morbidities, as discussed in Section 4.1.1 above.

#### 4 RESEARCH EXAMINING ASSOCIATION OF SOCIAL MEDIA USE WITH ADDICTIVE USE, DEPRESSION, SELF-HARM, BODY IMAGE DISSATISFACTION AND EATING DISORDERS

95. In this section, I present an overview of the body of research using the different designs that I briefly discussed above to determine the association of social media use with significant anxiety, insomnia, depressive symptoms, suicide, body image dissatisfaction and eating disorders - the mental health problems that have received the most attention in research. But before that I will discuss results of survey studies that have examined the prevalence of social media addiction and studies that have examined association of social media addiction with other mental health outcomes.

##### 4.1 Social media use can lead to problematic or addictive use

96. Much attention in recent years has focused on problematic or addictive use of social media platforms. In this section I review problematic or addictive use of social media, its characteristics, mechanisms and association of social media addiction with other mental health outcomes. In future sections of this report I discuss research, including internal research, showing links between the overall design and features of social media platforms and development of problematic use by children and adolescents.

##### 4.1.1 What are the characteristics of problematic or addictive use?

97. Social media addiction is a behavioral addiction, comparable to other types of addiction, in which repeated exposure to highly pleasurable stimuli (e.g., receiving “likes” or positive comments on posts) leads to hypersensitization of certain reward systems in the brain that selectively respond to cues (Seo and Ray 2019). Researchers have noted remarkable similarities between substance (i.e., drugs and alcohol) and non-substance addictions (Antons, Brand, and Potenza 2020). Both are characterized by engaging in rewarding behaviors repetitively and having diminished control over engagement in these behaviors, as is reflected in continued participation despite experiencing negative consequences. The negative consequences may be subjective distress, or impairment in functioning resulting in relational, occupational, or educational problems (Antons, Brand, and Potenza 2020).

98. Despite clear similarities with other behavioral addictions, there is currently no category of “social media addiction” among the formal diagnostic categories for mental disorders listed in the Diagnostic and Statistical Manual of Mental Disorders-fifth edition (DSM-5)

published by the American Psychiatric Association or the International Classification of Diseases (ICD-10) published by the World Health Organization. Although a category and diagnostic criteria for “gaming disorder,” which is also a behavioral addiction, were added in the new edition of the ICD, the ICD-11.

99. While data indicate that many adolescents nowadays spend large amounts of time on social media, not all of these adolescents can be considered as problematic users. In the largest individual-participant meta-analysis of its kind based on the 2017-18 Health Behavior in School Aged Children survey conducted in 29 countries (n=154,981), Boer and colleagues estimated the prevalence of problematic (addictive) social media use to be 7.38% (Boer et al. 2020).
100. Investigators generally believe that to be defined as addictive or problematic use, the elements of loss of control over the behavior, compulsive use, withdrawal (i.e., distress and craving when not using), and interpersonal or health-related problems should be present (Boer et al. 2020; Yue et al. 2022; Van Den Eijnden et al. 2018).
101. Diagnostic criteria for social media addiction have been proposed and several questionnaires and scales have been developed and validated to measure social media addiction; both diagnostic criteria and addiction scales are extensively represented and widely accepted in literature. The best known of these scales are the Bergen Facebook Addiction Scale (BFAS) and the Bergen Social Media Addiction Scale (BSMAS) which is based on BFAS but asks about social media in general rather than only Facebook (Yue et al. 2022). The full BFAS and BSMAS include 18 items, 3 for each of the 6 domains of “salience,” “tolerance,” “mood modification,” “relapse,” “withdrawal” and “conflict”. The abbreviated 6-item versions of these scales have also been produced with questions capturing frequency of experiences or behaviors representing each of the 6 domains of addiction. **Table 1** below presents the brief BFAS scale. Each item is scored on a 5-point Likert scale, with responses ranging from Very rarely (=1) to Very often (=5).

102.	<b>Table 1: Brief version of the Bergen Facebook Addiction Scale</b>
103.	<i>How often during the last year have you . . .</i>
104.	Spent a lot of time thinking about Facebook or planned use of Facebook? (Salience)
105.	Felt an urge to use Facebook more and more? (Tolerance)
106.	Used Facebook in order to forget about personal problems? (Mood modification)
107.	Tried to cut down on the use of Facebook without success? (Relapse)
108.	Become restless or troubled if you have been prohibited from using Facebook? (Withdrawal)
109.	Used Facebook so much that it has had a negative impact on your job/studies? (Conflict)

110. Many research studies of social media addiction use the full or the abbreviated versions of BFAS or BSMAS to define social media addiction (Turel, Brevers, and Bechara 2018; Mamun and Griffiths 2019; Duradoni, Innocenti, and Guazzini 2020; Panea-Pizarro et al. 2020; Rachubinska, Cybulska, and Grochans 2021; Uram and Skalski 2022; Yue et al. 2022). Other studies use questionnaires that are similar in content to BFAS/BSMAS



(Boer et al. 2020; Van Den Eijnden et al. 2018). Despite differences in the number of items and wording of specific items, questionnaires of social media addiction share several common core features including spending an excessive amount of time on these media at the cost of giving up other important social and academic activities or work-related obligations; unsuccessful attempts to cut down on social media use; experiencing the urge to spend an ever-increasing amount of time on these media; using social media as a distraction from other personal or interpersonal problems; and feeling restless if unable to access social media. These core features are similar to core features of many other addictions and reflect loss of control over the addictive behavior.

111. Some studies used the term “problematic social media use” to refer to an addictive pattern of social media use (Boer et al. 2020; Banyai et al. 2017). Some of these studies even used BSMAS (Worsley et al. 2018; Quaglieri et al. 2021; Banyai et al. 2017) or other questionnaires of social media addiction (Boer et al. 2020) to measure “problematic use”. For example, a recent review of the association between “problematic social media” use and other mental health outcomes included only studies that used a validated questionnaire for social media addiction; “[p]roblematic social media use scales must have been validated to specifically measure social media use in terms of addictive use, comprising criteria used when measuring substance use disorders.” (Shannon et al. 2022). As such, here I use both the terms social media addiction and problematic social media use to reflect what studies measured, but note that while the scales assess similar factors, there is a range in severity across problematic use and addiction.

#### 4.2 The mechanisms of addictive use of social media are similar to those of drug addiction

112. There is a consensus among experts that most drugs of abuse exert their initial reinforcing effects by activating reward circuits in the brain which are associated with pleasure. These pleasurable experiences correlate with activity in the dopaminergic circuits of the brain (Kalivas and Volkow 2005)—brain circuits that release the neurotransmitter dopamine. Research has consistently shown that administration of most drugs of abuse is associated with increases dopaminergic activity in the basal ganglia, structures located in the lower parts of the brain and associated with basic physiological activities and learning. Dopamine projections to the basal ganglia and cortex are important in facilitating the encoding of learned associations between drug taking and a sense of pleasure. These learned associations are an important element of addiction.
113. Continued drug use impairs brain function by interfering with the capacity to exert self-control over drug-taking behaviors and making the brain more sensitive to stress and negative moods (Kalivas and Volkow 2005). While release of dopamine in basal ganglia is essential for the experience of “drug high,” consolidation of an addictive pattern of drug use which is characterized by periods of craving, drug use and withdrawal involves the neuronal changes in the cortex and other neural systems (Kalivas and Volkow 2005).
114. Similar neurobiological changes have been observed in several non-substance addictions as well (Antons, Brand, and Potenza 2020) including overeating and obesity (Soroceanu et al. 2023), gambling addiction (Pettorruso et al. 2020), internet addiction (Weinstein and Lejoyeux 2015) and gaming disorder (Wen et al. 2021). For example, in gambling addiction, random winnings (reward) lead to continued gambling despite

financial, social and family problems often associated with gambling. Reviewing literature on gambling addiction, Pettorruso and colleagues noted that

“...a cocaine-like endogenous dopamine ‘intoxication’ may mediate several – but not all – symptoms that characterize [gambling disorder]. Excitement despite losses, dissociative symptoms, near-misses, as well as alterations in cognitive control (including decision-making, cognitive flexibility and delay discounting) are among the phenomena attributable to dopamine ‘intoxication’”. (Pettorruso et al. 2020)

115. In the context of social media addiction, receiving random “likes” and positive comments on posts or profile pictures may have a similar rewarding effect as winnings from a slot machine, leading the user to continue posting new comments and pictures in the hope of receiving future positive feedback. In a study of over one million social media posts from over 4000 individuals on multiple platforms, Lindstrom and colleagues found that posting patterns of these individuals consistently conformed to the principles of reward learning (Lindstrom et al. 2021). Social media users spaced their posts to maximize the average rate of accrued social rewards (e.g., “likes”).
116. There is some limited imaging evidence supporting neuro-anatomical changes in the brains of young adults associated with the level of addictive use of social media. Specifically, in a study of 20 young adults (mean age 20 years), smaller gray matter volume of the amygdala was associated with social media addiction scores on a standardized measure of social media addiction (He, Turel, and Bechara 2017). These changes in the amygdala have been shown to be related to strong impulsive behaviors. In this respect, social media addiction is similar to other types of substance and behavioral addictions, which are also associated with reduced gray matter volume of the amygdala. Another recent study suggests that social media checking in adolescents was associated with decreased sensitivity to social anticipation over time, indicating developmental changes (Maza et al. 2023).

#### 4.3 Addictive use of social media is associated with other adverse outcomes

117. In addition to the distress and impairment in social, academic, and occupational functioning associated with social media addiction, this condition is causally linked with significant comorbid psychological problems as well and may be considered an intermediate cause or mediator of the association of excessive social media use and adverse mental health outcomes. Research indicates that children and adolescents with social media addiction are more likely to be distressed and depressed (Duradoni, Innocenti, and Guazzini 2020; Rachubinska, Cybulska, and Grochans 2021; Mamun and Griffiths 2019), to have an eating disorder (Panea-Pizarro et al. 2020) and to engage in self-harm behavior (Brailovskaia, Teismann, and Margraf 2020; Khalil, Kamal, and Elkholy 2022).
118. A recent meta-analysis of 21 studies of adolescents and young adults examined association of social media addiction with symptoms of depression, anxiety, and stress (Shannon et al. 2022). Findings from this meta-analysis were consistent with an earlier meta-analysis by Cunningham and colleagues (Cunningham, Hudson, and Harkness 2021) and identified significant correlations between social media addiction scores with



depressive symptoms ( $r=0.257$ ), anxiety symptoms ( $r=0.342$ ), and stress scores ( $r=0.313$ ), all measured using validated questionnaires. Thus, in addition to being distressful and impairing by itself, social media addiction is associated with an excess mental health burden in the form of comorbid mental health conditions which further impact the lives of affected children and young people.

119. A more recent meta-analysis of 38 studies of Turkish population examined the association between problematic social media use and depression (Yigiter, Demir, and Dogan 2024). The study included a range of ages, with the average age of 22.5 years. The correlation coefficient between social media addiction and depression was  $r=0.321$ . The association in studies limited to high school students was somewhat smaller ( $r=0.281$ ). No evidence of publication bias was found. Overall, the results of meta-analyses are consistent, showing a Pearson correlation coefficient in the 0.25-0.35 range.

#### 4.3.1 Industry's research on addictive or problematic use

120. While this report is mainly based on academic research conducted by independent academic investigators, there is remarkable consistency between this research and the research conducted by researchers working for social media companies on the negative mental health effects of social media. This consistency is important to note because, if anything, the embedded researchers of social media companies are more likely to be biased to find no adverse effects of excessive use of social media platforms, or at least, less likely to find adverse effects for their own company's products. However, this research supports the conclusions of independent researchers regarding the harms associated with excessive social media use.
121. For example, in one of the reports disclosed by the whistleblower Frances Haugen, a Facebook intern named Will Essilfie disclosed a study in which he estimated the percentage of Facebook users who may be "addicted" to this app (Haugen\_00016893). The post notes that in every week of 2017 5.9 million Facebook users deactivated their account because they spent too much time on Facebook and that their leave was temporary and they planned to return (Haugen\_00016893 at Haugen\_00016898). The report goes on to say: "This subset provided a good signal for people who could be addicted" (Haugen\_00016893 at Haugen\_00016898). The investigators found that these users had more frequent sessions before they left compared to other users (Haugen\_00016893 at Haugen\_00016900). They also conducted an online survey of "Facebook addiction" with 1,300 Facebook users and found that those who endorsed addiction symptoms tended to spend more hours on Facebook and had more sessions (Haugen\_00016893 at Haugen\_00016903-Haugen\_00016907). Based on these insights they created a model to estimate the prevalence of Facebook addicted individuals in the US as between 15,000 to 200,000 (Haugen\_00016893 at Haugen\_00016907).
122. A 2021 Wall Street Journal article based on the Haugen files highlighted the internal research in Facebook regarding problematic use (Wells, Seetharaman, and Horwitz 2021). The article noted that 1 in 8 of Facebook users engage in what was referred to as "compulsive" or problematic use of social media that impacted their sleep, work, parenting and relationships. The Facebook team involved in this research noted a number of algorithmic features that likely contributed to this problem and suggested a number of fixes

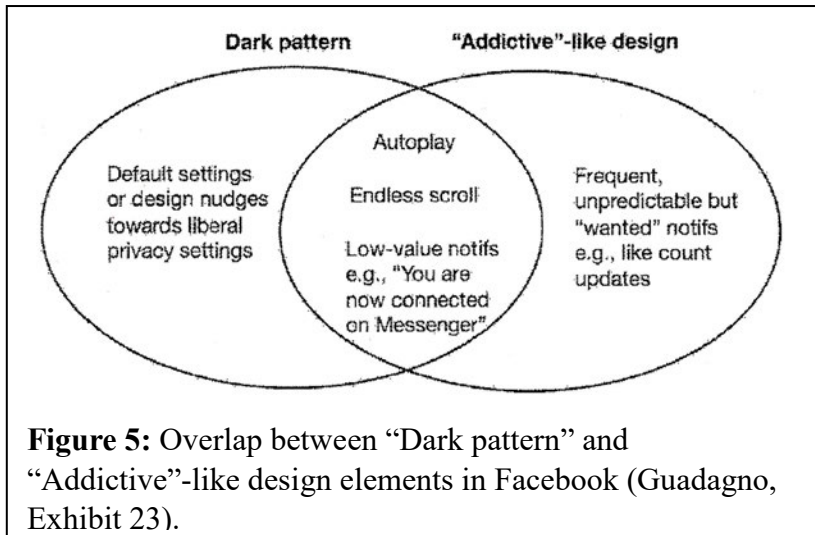
for the problem, including breaks from social media and notifications that aim to make people visit the platform frequently.

123. In a literature review commissioned by the team titled “Addiction to Facebook: A literature Review”, the review’s author Matt Killingsworth noted that Facebook “could be addicting in ways similar to gambling or other compulsive behavior” (Deposition of Jennifer Guadagno, Phd, November 14, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21 (META3047MDL-005-00000001 at META3047MDL-005-00000003). These concerns were also echoed in a 2018 Facebook internal document which highlighted some of the concerns discussed internally regarding the need for further work to understand the association of some of the algorithmic features of Facebook and problematic use:

“...academics are debating whether 1. FB is truly “addictive”, and 2. What standardized definitions we should use to identify FB addiction or problematic FB use... The well-being team has reframed the addiction narrative to focus on ways that FB may be contributing to use patterns that people find difficult to control despite negative impacts in their lives, and to identify and correct those contributing factors. Specifically, what are the ways that FB can seem rewarding or reinforcing without delivering real value, and what are the types of habitual FB behaviors that people find unwanted and difficult to change?” (Deposition of Jennifer Guadagno, Phd, November 14, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047) Testimony of Dr. Jennifer Guadagno, Exhibit 23).

124. The document also notes similarities between “addictive”-like design elements and “dark patterns”. A dark pattern was defined as a “UX” [user experience] term referring to interactions that are deceptive, or that trick you into doing something you did not want to do. These include misleading or manipulative features or settings that are designed to encourage a particular behavior that is not necessarily in the user’s best interest. These can include single instance behaviors.
125. “Addictive”-like design elements, on the other hand, “are those that promote repeated or poorly regulated behaviors that may have a negative impact on the individual over time as they continue behaviors that aren’t in their best interest.” **Figure 5** from an internal Facebook document highlights the overlap between “dark pattern” and “addictive-like design elements” (Deposition of Jennifer Guadagno, Phd, November 14, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 23 (META3047MDL-044-00108564 at META3047MDL-044-00108566)).

126. In a 2019 paper, Facebook investigators Justin Cheng and colleagues published a study based on a survey of more than 20,000 Facebook users in which they queried perceptions of problematic use along with data on server logs of aggregated behavioral data for the previous four weeks, including the amount of time respondents spent on the



site and counts of interactions with close friends (Cheng, Burke, and Davis 2019). Combining self-report data with objectively measured online behavior reduces the risk of bias that can arise in purely self-reported data.

127. The authors of this paper defined problematic Facebook use by two criteria:

(1) Negative life impact attributed to Facebook:

- Facebook hurts their relationships "very much," or
- They "very often" or "always" get less sleep because of Facebook, or
- Facebook hurts their work or school performance "greatly," or
- Facebook has a "very negative" impact on their lives

(2) Problems with control or preoccupation:

- "Very little or no control" over the time they spend on Facebook, or
- "Very" or "Extremely" concerned about missing posts from not logging in frequently enough

128. They found that, on average, 3.1% of Facebook users in the U.S. experience problematic use based on both criteria. Problematic use was most common among teens and young adults (**Figure 6**), reaching 10% in adolescent boys. Male participants in general and those who had experienced a recent negative life event (e.g., a breakup of relationship) were more likely to have problematic use. Those with problematic use spent 21.6% more time on Facebook and had 13.5% more frequent visits to Facebook. They were also more likely to use Facebook late at night (Cheng, Burke, and Davis 2019). Of interest, while the paper reported 3.1% of Facebook users to experience problematic use, an internal Meta document authored by Dr. Jennifer Guadagno, Director of UX (User Experience) Research and Social Impact (Deposition of Mark Zuckerberg, Volume I, March 27, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), at Exhibit 35) showed that mild problematic use had a 55% prevalence, and 3.1% had "severe" problematic use (META3047MDL-053-00028484-META3047MDL-020-00263114; Zuckerberg Dep., March 27, 2025). The document also referred the social comparison as a "negative driver," with a prevalence of 40% mild and 5% severe (META3047MDL-053-00028484; Deposition of Mark Zuckerberg, Volume I, March 27,

2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), at 259:12-259:19, Exhibit 38).

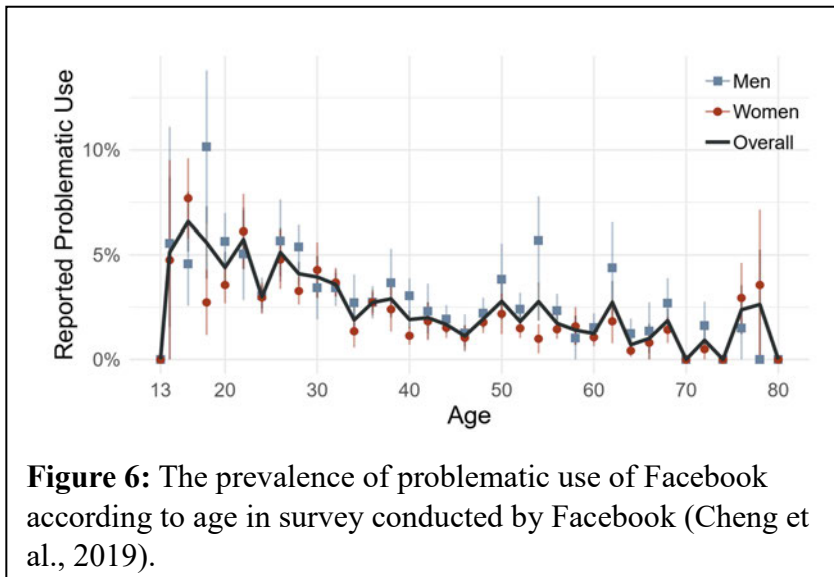
129. In another report, Facebook researchers noted that “The best external research indicates that Facebook’s impact on people’s well-being\* is negative”

(META3047MDL-079-00000177 at META3047MDL-079-00000182-00000272).

The report goes on to state: “We’ve

identified 3 drivers that might be contributing to negative well-being:

Problematic use, Loneliness, and Social Comparison” (META3047MDL-079-00000177 at META3047MDL-079-00000182). The report then describes a qualitative study to “unpack” problematic use, in which the investigators interviewed 24 “problematic Facebook users” (META3047MDL-079-00000177 at META3047MDL-079-00000178, META3047MDL-079-00000182). These individuals described lack of control and feelings of guilt over their use of Facebook and negative impact on productivity, sleep, parenting or relationships. The report estimates that approximately 12.5% of Facebook users are problematic users, with rates as high as 25% in the Philippines. (META3047MDL-079-00000177 at META3047MDL-079-00000183).



**Figure 6:** The prevalence of problematic use of Facebook according to age in survey conducted by Facebook (Cheng et al., 2019).

130. In another survey conducted by Instagram investigators, 40% of the users of this app reported finding it difficult to manage the amount of time they spent on social media generally, 38% spent more time on the app than they liked, and 23% felt that they had no control over the time they spent on the app (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 30 (META3047MDL-003-00156738 at META3047MDL-003-00156763)).

#### 4.4 Problematic social media use is causally associated with depressive and anxiety symptoms

131. Numerous studies have examined the association between the extent of social media use and mental health problems using different designs. Over the years, several meta-analytic reviews have synthesized this body of research. In this section I will briefly review the meta-analytic reviews that provide a summary of this research on the association of social media use with depressive and anxiety symptoms and disorders. Lastly, I will review important longitudinal and experimental studies in more detail as they provide the strongest case for a causal relationship based on Hill’s guidelines.

132. Of note, several studies use the term internalizing symptoms instead of depressive symptoms. The term internalizing symptoms is often used to describe symptoms of depressed mood, low motivation, anxiety, negative thoughts about self and suicidal ideations in children and adolescents. Internalizing symptoms are often contrasted with externalizing symptoms which include rule breaking behavior, frequent fighting and other aggressive behavior. In this report, I consider internalizing symptoms virtually synonymous with depressive symptoms and use the terms interchangeably.

#### 4.4.1 Meta-analyses support the link between social media use and depressive symptoms

133. I identified 11 meta-analyses that specifically examined the association of social media use with depressive symptoms and suicidal ideations/behaviors (Cunningham, Hudson, and Harkness 2021; Huang 2017, 2022; Ivie et al. 2020; Liu et al. 2022; Yoon et al. 2019; Shin et al. 2022; Vahedi and Zannella 2021; Marino et al. 2018; McCrae, Gettings, and Purssell 2017; Baker and Algorta 2016; Lee et al. 2022). In addition, I reviewed several studies that provided systematic reviews of the literature without conducting a formal quantitative summary in the form of a meta-analysis (Keles, McCrae, and Grealish 2020; Seabrook, Kern, and Rickard 2016). As the conclusions of these reviews were mainly consistent with the meta-analyses, I will not discuss them further.

134. Because there is significant overlap in primary studies used in these meta-analyses, I will focus on meta-analyses published after 2016. Most primary studies used in meta-analyses published before this date are included in later meta-analyses. Also, because the group of most interest to me is adolescents and young adults, I will emphasize meta-analyses that specifically addressed youth, reported data for youth separately or at a minimum reported whether age was a moderator in their meta-analysis (i.e., was related to the outcome).

135. The largest meta-analysis addressing social media use and mental health problems was published by Huang in 2022 and included 132 independent samples encompassing 244,676 participants among whom the associations of excessive, addictive or problematic social media use with other mental health outcomes were assessed (Huang 2022). The meta-analysis was not limited to adolescents and primary studies with mean age of 13 to 50.1 years were included (mean age across studies=21.9 years). The study found medium sized correlations between problematic social media use and mental health problems. In **Table 2** below, I reproduce part of this meta-analysis results that are most relevant to the topic of this review (based on Table 3 of the meta-analysis).

<b>Table 2:</b> Association of problematic use of social media and mental health problems in the Huang 2022 meta-analysis (partial data from Table 3 of the meta-analysis).			
<b>Mental health outcome</b>	<b>Number of primary studies</b>	<b>Correlation coefficient</b>	<b>95% confidence interval around correlation coefficient</b>
Depression	59	.31	.28, .33
Anxiety	17	.30	.25, .35
Overall distress	4	.27	.01, .49
Negative affect	4	.08	-0.29, .44



Social anxiety	17	.30	.24-0.35
Suicidal ideations	3	.18	.02, .34

136. The author was also able to conduct meta-regression analysis in the largest sample of studies that examined association of social media use with depression to see if factors such as the country where the study was conducted (US, Turkey, Germany and Netherlands), the specific instrument used for assessment of depression, how problematic social media use was assessed, mean age of study participants and the sex composition of the study sample made a difference in the associations. Meta-regression is a type of statistical analysis to examine the association of characteristics of primary studies in a meta-analysis with the results of those primary studies. None of the variables included in Huang's meta-regression modified the association of social media use with mental health problems. No publication bias was identified, supporting the validity of the study results.
137. One limitation of this meta-analysis is that it mixed longitudinal and cross-sectional analyses. Nevertheless, consistency across studies conducted in different countries, across different samples and age groups, and using different measures of mental health problems is remarkable. As noted, consistency of findings is one of the Bradford Hill guidelines for establishing causal links. Assessment of mental health problems was based on standard questionnaires with established reliability and validity.
138. The meta-analysis by Liu and colleagues focused on examining the dose-response relationship of hours of social media use daily with depression in adolescents (Liu et al. 2022). A total of 21 cross-sectional studies and 5 longitudinal studies were included (total n=55,340 participants). The authors reported the outcomes in the odds ratio metric which, for consistency with the other meta-analyses, I converted to correlation coefficients using standard formulas (Borenstein et al. 2009) that were implemented in the online *Effect Size Converter* (<https://www.escale.site/>). The meta-analysis did not identify any publication bias. The pooled effect size from all included studies was  $r=0.13$  (95% CI=0.10-0.16). The effect sizes were significant and very consistent among cross-sectional ( $r=0.13$ , 95% CI=0.10-0.16) and longitudinal studies ( $r=0.12$ , 95% CI=0.10-0.15). The effect sizes were larger for girls ( $r=0.15$ , 95% CI=0.09-0.20) than boys ( $r=0.05$ , 95% CI=0.01-0.09) based on 4 studies that reported separate effect sizes among genders.
139. The meta-analysis by Yoon and colleagues examined the use of social media and its relationship with depression in 45 studies (Yoon et al. 2019). No publication bias was noted. The meta-analysis included a mix of studies of adults and adolescents. Separate analyses were conducted for time spent on social media, frequency of social media checking, upward social comparison, and general social comparison. In upward social comparison the user envies others portrayed on social media or considers their achievements higher than his or her own, whereas in general social comparison the user simply compares herself or himself with others portrayed on the media and does not make an upward or downward comparison. The studies included were mostly cross-sectional. The correlation of time spent on social media with depression was significant ( $r=0.11$ , 95% CI=0.08-0.14), as was the correlation of checking frequency ( $r=0.10$ , 95% CI=0.03-0.16). No age or gender differences were found for these associations. The correlations for general social comparison ( $r=0.23$ , 95% CI=0.12-0.34) and for upward social comparisons ( $r=0.33$ , 95% CI=0.20-0.47) were larger, but they were based on only 5 studies. The authors

concluded that their findings supported the causal effect of social media use, especially upward comparisons with depression.

140. The meta-analysis by Ivie and colleagues examined the association between time spent on social media and depressive symptoms in adolescents (Ivie et al. 2020). Eleven studies with 92,371 participants were included. No publication bias was identified. All but one study was cross-sectional. The pooled correlation coefficient was significant and similar to that found in other studies ( $r=0.12$ ; 95% CI=0.08-0.16).
141. The meta-analysis by Shin and colleagues on the association between “online media consumption” and depression is perhaps the largest meta-analysis of this kind and identified 531 cross-sectional and longitudinal primary studies among young people (ages 10-24 years)(Shin et al. 2022). The definition of online media in this study is quite broad and includes all kinds of online media. However, the study assessed variations by type of media (social media, smartphone, online gaming) through meta-regression analysis, a method of examining the association of characteristics of primary studies with the study results. The authors concluded that the majority of cross-sectional and longitudinal studies showed an association between “online media use” and depression. They reported a correlation of  $r=0.25$  between social media use and depression in cross-sectional studies and a correlation of  $r=0.12$  between baseline social media use and follow-up depression in longitudinal studies (confidence intervals not reported). They also found a relationship between depression at baseline and online media use in the follow up in longitudinal studies, suggesting that youth with depression are more likely to use social media excessively when assessed later. Furthermore, they reported a larger association in young adults compared to adolescents.
142. Cunningham and colleagues’ meta-analysis specifically examined whether excessive time on social media, intensity of use or problematic use were associated with depressive symptoms(Cunningham, Hudson, and Harkness 2021). Their meta-analysis included 44 analyses examining time spent using social media, 6 analyses examining social media use intensity (i.e., emotional connectedness and the extent to which social media use is integrated into daily life), and 20 analyses examining problematic use (i.e., an addictive pattern of use). These analyses came from 62 papers with 45,229 participants across the age range (some papers included more than one analysis). This meta-analysis was also unusual in that it found a publication bias in studies examining time spent on social media. The correlations of these three different exposure types with depressive symptoms varied significantly. The correlations of depressive symptoms with time spent on social media ( $r=0.11$ , 95% CI=0.09, .13) and intensity of social media use ( $r=0.09$ , 95% CI= -0.003, 0.18) were smaller than with problematic social media use ( $r=0.29$ , 95% CI=0.23, 0.35). The studies included a range of ages. However, the associations did not differ across studies with different average ages or different proportion of females.
143. The meta-analysis by Vahedi et al. also examined the association between different operationalizations of excessive social media use and depressive symptoms (Vahedi and Zannella 2021). The authors identified 55 studies with 80,533 participants that examined the association between frequency of social media use or problematic social media use and depressive symptoms. Both adult and adolescent studies were included. No publication bias was detected. The meta-analysis found a small but statistically significant correlation

overall ( $r=0.17$ , 95% CI=0.13, .20) which was stronger for addictive use, as well as in studies that investigated specific social media interactions such as upward social comparisons and experiences of cyberbullying ( $r=0.27$ , 95% CI=0.21-0.34) compared to studies that simply examined association with frequency of social media use ( $r=0.11$ , 95% CI=0.07-0.14). The effects did not vary according to the average age of the study participants or their gender distribution.

144. Marino and colleague's meta-analysis was limited to problematic use of Facebook and its association with depressive or anxiety symptoms and other psychological problems. Primary studies included adolescents and young adults with a mean age of 21.9 years across studies (Marino et al. 2018). The authors identified 23 studies with 13,929 participants that reported on these associations. No publication bias was identified. The correlation coefficients for different mental health problems were quite similar:  $r=0.30$ , 95% CI=0.25, .35 for depression,  $r=0.29$ , 95% CI=0.24, .34 for anxiety, and  $r=0.29$ , 95% CI=0.24, .34 for psychological distress.

#### 4.4.2 Evaluating the meta-analyses

145. Below I present some conclusions regarding the meta-analyses of association of social media use with depressive symptoms.
  - a) All but one of the meta-analyses failed to identify a publication bias. As previously noted this is understandable given that the topic of impact of social media on mental health problems is currently a widely discussed topic of public interest. Therefore, most papers on this issue are published irrespective of the findings. As such, the findings of meta-analyses are unlikely to be impacted by publication bias. The result of publication bias is that the pooled effects in meta-analyses are inflated because only primary studies with significant results (e.g., larger studies or studies with larger effect sizes) that tend to be statistically significant are published. It is possible to examine publication bias in a meta-analysis by appropriate statistical methods. Absence of publication bias suggests that primary studies were not "cherry picked" based on their results and the pooled effect size in the meta-analysis is a fair representation of the association in the population of interest.
  - b) In the context of high heterogeneity among study results in many meta-analyses, it is notable that most studies found a significant correlation in the range of  $r=0.11$  to 0.30 between frequency and duration of social media use and depressive symptoms. The two meta-analyses limited to adolescent studies (Liu et al. 2022; Ivie et al. 2020) reported  $r=0.12$  and 0.13. These two meta-analyses shared only 7 studies (7 of the 12 studies in Ivie's meta-analysis and 7 of the 26 studies in Liu's meta-analysis). This consistency was noted even across cross-sectional and longitudinal studies. No meta-analyses reported null findings. The results as such are consistent and support one of the major Hill guidelines, i.e., consistency across studies.
  - c) Forms of engagement with social media appear to be important predictors of association (Yoon et al. 2019; Vahedi and Zannella 2021; Cunningham, Hudson, and Harkness 2021). More problematic engagement with social media (e.g., addictive use as described above) was associated with larger correlations with



depressive symptoms (Vahedi and Zannella 2021; Cunningham, Hudson, and Harkness 2021).

- d) Upward comparison, in which the person compares herself or himself unfavorably with their peers on social media was also associated with a larger correlation with depressive symptoms (Yoon et al. 2019; Vahedi and Zannella 2021).
- e) Except for the meta-analysis by Marino and colleagues (Marino et al. 2018) that was limited to primary studies of Facebook use, other meta-analyses pooled primary studies of social media irrespective of specific platform.

#### 4.4.3 Longitudinal studies support a causal association between problematic social media use and depressive symptoms

146. While a majority of studies of the association of social media use with depression and anxiety symptoms are cross-sectional, several studies examined the longitudinal association between excessive baseline social media use with depression and anxiety symptoms at follow-up (Frison and Eggermont 2017; Riehm et al. 2019; Boers et al. 2019; Booker, Kelly, and Sacker 2018; Brannigan et al. 2022; Davison et al. 2022; Faelens, Hoorelbeke, Soenens, et al. 2021; Li et al. 2022; Mundy et al. 2021; Nesi and Prinstein 2015; Orben et al. 2022; Primack et al. 2021; Shakya and Christakis 2017; Coyne et al. 2020; Erevik et al. 2021; Beeres et al. 2021; Puukko et al. 2020; Raudsepp and Kais 2019; Gentzler et al. 2023). Reviewing the results of the major longitudinal studies is important because one of the criticisms of cross-sectional studies is that they cannot establish the temporal order of social media use and mental health outcomes, one of the important of Hill's guidelines for a causal relationship. Longitudinal studies are designed to capture the temporal order of cause and effect.

147. In line with cross-sectional studies, most of the longitudinal studies found significant associations between the extent of social media use and depression and anxiety (Mundy et al. 2021; Boers et al. 2019; Riehm et al. 2019; Gentzler et al. 2023; Stockdale and Coyne 2020), although, some found that the association was limited to specific use or context, e.g., use out of boredom (Stockdale and Coyne 2020) or found no significant effect (Coyne et al. 2020; Erevik et al. 2021; Beeres et al. 2021; Puukko et al. 2020).

148. To highlight the potential strengths of longitudinal studies, below I discuss the results of three well-constructed longitudinal studies (Mundy et al. 2021; Boers et al. 2019; Riehm et al. 2019) which focused on adolescents and specifically adjusted the analyses for pre-existing mental health problems. By adjusting for pre-existing mental health problems these studies try to eliminate the effect of these problems on social media use and thus examine the causal effect of excessive social media use on depressive symptoms at a future time point (i.e., ruling out reverse causation).

149. The study by Mundy and colleagues (Mundy et al. 2021) examined both cross-sectional and longitudinal associations of social media use with depressive symptoms in a seven-year study of 1,156 third graders (ages 8-9 years at baseline) drawn from a random sample of 43 primary schools (Government, Catholic, Independent) in Melbourne, Australia. Duration of social media use was measured annually at four follow-up waves

(waves 4 to 7). Participants reported on their social media use in a typical school day. Validated measures for depression and anxiety were used. Both cross-sectional and longitudinal relationships between social media use and depressive and anxiety symptoms were examined. In analyses that adjusted for age, socioeconomic status, and prior mental health history, females with high social media use (more than 1 hour daily) had greater odds of depressive symptoms (OR=2.15; 95% CI=1.58–2.91; corresponding to  $r=0.21$ , 95% CI=0.13, .28) and anxiety symptoms (OR=1.99; 95% CI=1.32–3.00;  $r=0.19$ , 95% CI=0.08, .29) compared to those who used social media for a few minutes per day, while males with high social media use had 1.60 times greater odds of reporting depressive symptoms (95% CI=1.09–2.35; corresponding to  $r=0.13$ , 95% CI=0.02, .23). In longitudinal analysis among females, increased odds of depressive symptoms at an average age of 14.8 years was observed for high social media use in 1 previous wave (OR=1.76; 95% CI=1.11–2.78; corresponding to  $r=0.15$ , 95% CI=0.03, .27) or 2-3 prior waves (OR=2.06, 95% CI=1.27–3.37; corresponding to  $r=0.20$ , 95% CI=0.07, .32), compared to use of social media for only a few minutes. The models adjusted for anxiety and depressive symptoms at waves 1-3. The associations for boys were similar in direction but did not reach a statistically significant level. The strength of this study is that it adjusted for depressive and anxiety symptoms at a relatively young age (8-9 years).

150. In the study by Boers and colleagues (Boers et al. 2019) a sample of 3,826 adolescents were recruited from 31 schools in the Greater Montreal area in 2012 and studied from grade 7 to 11 (mean age: 12.7 years). Students completed a confidential annual web-based survey during class time to assess screen time (measured separately for social media, computer games, watching shows, etc.) and symptoms of depression. Depression was measured on a 7-item validated questionnaire (range of scores: 0-28; mean=4.29, standard deviation=5.10). The associations with outcomes for both between-individual differences and change over time in the same person (within-individual differences) were examined. The study found significant effects for between-individual differences: for every 1 hour more time spent using social media, adolescents showed a 0.64 (95%CI, 0.32-0.81) higher score on the depressive symptom scale. In addition, every 1-hour change in the use of social media was associated with a 0.41 (95% CI, 0.32-0.51) increase in depressive symptoms in the same year (within-individual effect). Because it used a longitudinal design and assessed change within individuals, the study in effect adjusted for pre-existing level of depressive symptoms.

151. An important finding of Boers and colleagues' study was a significant interaction among the between-individual and within-individual effects, suggesting that individuals who experienced a higher level of depressive symptoms associated with social media use at one time point are also more likely to experience increased depressive symptoms if they increase their social media use at a future time (Boers et al. 2019). The authors described this finding as an indication of a "reinforcing spiral" and suggested that this reinforcing effect may be related to the algorithmic nature of social media:

"Based on reinforcing spirals, one may argue that adolescents with depression seek out information consistent with their depressive mindset, e.g., social media posts with depressive content. We posit that reinforcing spirals might be particularly relevant for screen time that features algorithm-based content feeding that is repeated inside a closed system (i.e., a filter

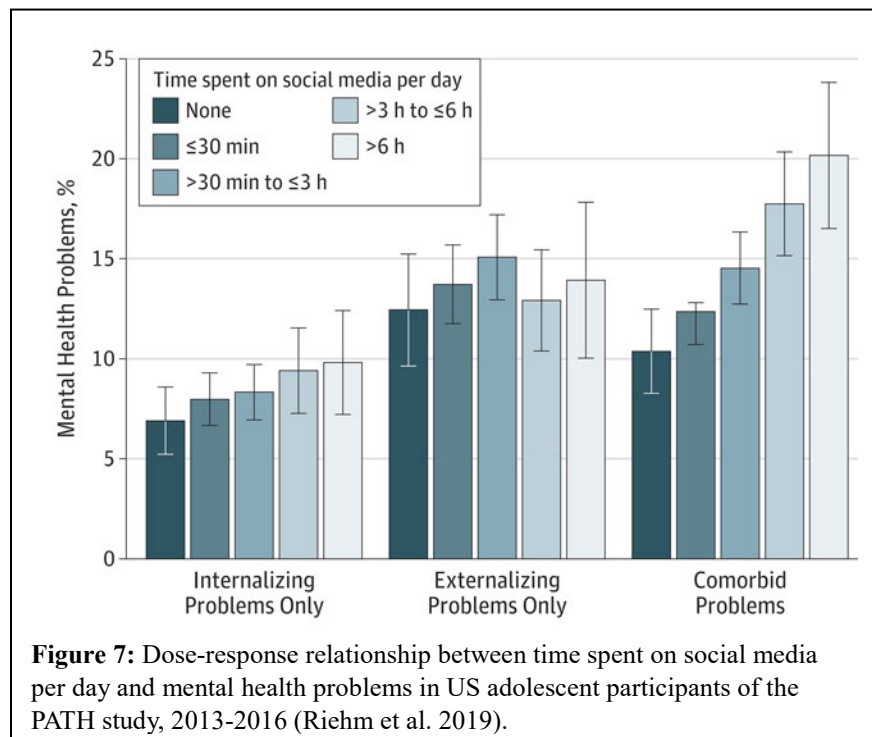
bubble). Within a filter bubble, algorithms automatically recommend content an individual is likely to be interested in based on previous search and selection behavior.” p. 854 (Boers et al. 2019)

152. While the Boers and colleagues’ study did not specifically examine different social media platforms, this finding of their study is relevant, as the algorithms of TikTok, Meta, YouTube, and Snap are all specifically designed to create a filter bubble by selectively offering users videos related to their interests as part of the design to maximize user engagement.
153. In interpreting the results of within-individual or adjusted longitudinal analyses, one caveat to consider is that these estimates may be conservative because some of the between-individual differences in symptoms at baseline may be due to the impact of social media use that has happened before the baseline. When we look only at within-individual associations of social media use with mental health outcomes we are, in effect, assuming that all of the harmful effects of social media started at the study baseline. In reality, children and adolescents may have already experienced harm due to excessive social media use that happened at an earlier age. For example, if the study recruits adolescents at age 13 to examine the effect of social media use on outcomes in future years, adolescents with more depressive symptoms at baseline may be more depressed because of their social media use that started at age 12 or 11. This effect is not captured in within-individual analyses that start in adolescence. This is also a limitation of some of the studies that did not find a statistically significant within-individual effect (Beeres et al. 2021; Coyne et al. 2020) and based on this finding concluded that there is no longitudinal association between social media use and mental health problems. In both studies by Beeres et al. and Coyne et al., between-individual associations were significant, indicating that there was an association between social media use and mental health outcomes at baseline, possibly due to the harmful effects of social media that happened earlier.
154. In another longitudinal study led by my doctoral student, Dr. Kira Riehm and overseen by me, we examined the association between social media use and internalizing symptoms in US adolescents (Riehm et al. 2019). We used data from the Population Assessment of Tobacco and Health (PATH) survey. PATH is a nationally representative, longitudinal cohort of adolescents interviewed annually. In our study, which was based on a sample of over 6,000 adolescents aged 12-15 years, we examined the association between social media use in Wave 2 of the study and internalizing as well as externalizing symptoms in wave 3 of the study conducted a year later. Internalizing symptoms consisted of symptoms of depressed mood, low motivation, anxiety, negative thoughts about self and suicidal thoughts or behaviors; whereas, externalizing symptoms consisted of rule-breaking behaviors and use of alcohol and other substances.
155. We used data from wave 2 on social media use to predict mental health problems at wave 3. We also adjusted the analyses for adolescents’ characteristics including their internalizing and externalizing problems and history of alcohol and drug use at wave 1, conducted a year before wave 2. In this way we tried to remove the potential confounding effect of these characteristics to rule out the reciprocal effect of these symptoms on social media use. One of the criticisms of research on the association between social media use

and mental health outcomes is that children with mental health problems may use social media more heavily to cope with their pre-existing mental health problems.

156. We also found a dose-response association between social media use and mental health problems in this study. A dose-response relationship means that a higher level of exposure to social media is associated with a higher likelihood of mental health problems. For example, compared to no use, the use of social media for more than 3 hours but less than 6 hours per day was associated with a 60% higher risk of internalizing problems and more than 6 hours of use was associated with 78% higher risk. Similarly, in the case of comorbid internalizing and externalizing problems, more than 3 hours but less than 6 hours of social media use was associated with two times higher risk and more than 6 hours of social media use with 2.44 times higher risk of such problems. No such relationship was observed for externalizing problems alone. This dose-response relationship is depicted in **Figure 7** from our paper.

157. As discussed earlier, a dose-response relationship is one of Hill's guidelines supporting a causal relationship between two variables. This research provides support for the view that social media is a contributing cause of depressive symptoms.



158. Our study was criticized in a letter to the editor for not adjusting for Wave 2 mental health problems (Keyes and Kreski 2020). However, Wave 2 mental health problems could be the result of social media use assessed at that Wave and mediate mental health problems at Wave 3. Adjusting for outcomes or mediators in a regression analysis is not justified and would produce erroneous results. We decided to only adjust for Wave 1 mental health problems which clearly predated Wave 1 (as per Hill's guideline of temporality).

159. Two recent multi-cross sectional studies stand apart from other cross sectional and longitudinal studies in that they examined similar samples of participants regularly over a period of time (Braghieri, Levy, and Makarin 2022; Mojtabai 2024). Although the studies did not follow the same individuals over time, and as such could not be described as longitudinal, they were not limited to one cross-sectional sample of the population.

160. The study by Braghieri and colleagues examined the average mental health effect of the gradual roll-out of Facebook in US colleges (Braghieri, Levy, and Makarin 2022). Facebook was created at Harvard in February 2004 and was rolled out in a staggered manner to other colleges in the United States and other countries over a period of 2.5 years. This staggered roll-out allowed researchers to assess its impact on college students' depressive symptoms using data from the National College Health Assessment survey. This study is different from other longitudinal studies in that it examined the association of Facebook roll-out in each college with the change in the average level of depressive symptoms in that college. This type of analysis is generally known as ecological as it is not based on individual participants but rather based on exposure and outcomes both measured at aggregate level. The study found that depressive symptoms increased on average by .085 standard deviation as a result of the introduction of Facebook. Based on this calculation, the authors estimated that about 24% of the increase in severe depression among college students over the last two decades can be explained by the introduction of Facebook.

161. In a more recent study, I examined the trends in depressive symptoms and association with time on social media among adolescents in a study of over one million students surveyed in 47 countries in Europe, North America, Middle East and Central Asia (Mojtabai 2024). The surveys were conducted in 4 waves 2005-2006, 2009-2010, 2013-2014, and 2017-2018. Prevalence of more severe depressive symptoms (feeling low, irritability or bad temper, feeling nervous, and difficulties in getting to sleep) increased from 6.7% in 2001–2002 to 10.4% in 2017–2018. The increase was especially large among girls age 15 and older: from 10.9 to 19.1%. More importantly, the use of problematic social media use or the excessive use of social media (almost constantly) fully explained the time trend in psychological symptoms. Overall, the findings of this very large study support the adverse mental health effects of excessive and problematic social media use.

#### 4.4.4 Experimental studies support a causal association between problematic social media use and depressive symptoms

162. A number of experimental studies have examined the immediate effects of social media use and, specifically, social comparisons through these platforms on changes in mood states (de Vries et al. 2018; Alfasi 2019; Lambert et al. 2022; Yuen et al. 2019; Ozimek and Bierhoff 2020). Few of these studies, however, specifically focused on children and adolescents. Nevertheless, as noted by Hill, experimental studies provide the most persuasive evidence in support of a causal relationship because they are free from confounding which could potentially bias the results of observational cross-sectional and longitudinal studies.

163. In a rare experimental study with adolescents, Weinstein surveyed and randomly assigned 507 teens (mean age=15.3 years) to three study arms: a “highlight reel” condition designed to induce upward social comparisons and two control arms designed to reduce negative consequences of social comparison (Weinstein 2017). The highlight reel arm included only positive Instagram feeds, showing people having a great time. The group in the second arm browsed the same feeds preceded by a reminder that most people post only their best moments and most flattering pictures on social media, not their struggles and bad days. The group in the third arm browsed more balanced versions of the feeds that included



non-positive content, specifically posts acknowledging that the person was having a “bad day.” These latter posts were drawn from public Instagram posts to the hashtag “#badday”.

164. Mood states immediately before and after browsing were assessed using Positive and Negative Affect Scales (PANAS). Reports on social comparisons in response to the featured accounts were also collected. Analyses controlling for baseline emotional state of participants indicated that regardless of browsing condition, teens who reported higher levels of upward social comparison had significantly worse post-browsing affect than peers who reported fewer upward comparisons. However, the arm to which the participant was assigned moderated the relationship between social comparison and affective state. The relationship between upward social comparisons and negative affect was more pronounced in those exposed to a “highlight reel” which only presented positive events in the feeds. The following quote from one the participants poignantly summarizes the study’s findings:

“I guess a lot of these photos would make me feel like questioning my worth [and] jealous of her. 'Cause it seems like she has a great life. She's pretty, she has nice friends, she has enough money to go on vacationing at that beach or something. [It] makes you feel like [it's] unattainable, the life she has ... Yeah, I can tell you that she looks like she has a good life. That she looks like she enjoys what she does... Yeah, I would both be jealous of them [the male and female] if I was involved in their feeds and not just looking at this for a social media survey ... 'cause it's like, if I knew them, then I'd be jealous of them having that life. Like why couldn't I have had that life? Why do they get it and not me, I guess .... They both look like they have great lives, perfect lives, and that they have fun and all that stuff.” (p. 403)

165. Of interest was that the assigned browsing condition (highlight reel with positive feeds, highlight feeds preceded by a reminder people were posting their best moments, and feeds including “bad days”) did not result in a difference in post-browsing state of mind. This finding, along with the negative affect in the group with more upward comparisons, suggests that negative comparison is not reflective of content differences as much as individual variations in response to browsing.
166. Two experimental studies specifically examined the impact of short exposures to social media images of people on the participants’ body image and body satisfaction among young women (Engeln et al. 2020; Sherlock and Wagstaff 2019). In one study, 129 women aged 18-35 years were randomly assigned to watch 10 manipulated Instagram posts depicting hashtags of travel, beauty or fitness. Women who viewed beauty or fitness Instagram posts had a significant decline in self-reported attractiveness scores. This change was associated with higher depressive symptoms, general anxiety, physical appearance anxiety, and body dissatisfaction, and with lower self-esteem scores (Sherlock and Wagstaff 2019).
167. Another set of experimental studies randomized participants to a brief interruption of social media use (Vanman, Baker, and Tobin 2018; Allcott et al. 2020; Tromholt 2016) or a regime of restricted time of social media use (Hunt et al. 2018). By temporarily removing the effects of social media, these studies seek to ascertain whether there is a causal link between excessive social media use and mental health problems.



168. Vanman and colleagues assigned 138 active Facebook users (Mage age= 22.4, range 18–40 years) to either a condition in which they were instructed to give up Facebook for 5 days or continue to use Facebook as before (Vanman, Baker, and Tobin 2018). Perceived stress and well-being, as well as salivary cortisol (a physiological marker of stress), were measured before and after the test period. Compared to those in the control condition, those in the Facebook holiday condition experienced lower levels of cortisol, indicating less physiological stress. However, they experienced a lower level of life satisfaction. The authors attributed the lower satisfaction to “the general ambivalent feelings” that the most active users may feel towards Facebook. The possibility of a withdrawal effect should also be considered, especially among those who use this medium excessively.
169. These results are somewhat different from the results of another study by Hunt and colleagues who randomized 143 undergraduates to either limit Facebook, Instagram and Snapchat use to 10 minutes, per platform, per day for three weeks, or to use social media as usual (Hunt et al. 2018). Social media use was assessed objectively by having subjects email screenshots of their iPhone battery usage which tracks the total minutes each application was actively used. The limited use group showed significant reductions in loneliness and depression over the three weeks compared to the control group. Both groups showed significant decreases in anxiety and fear of missing out over baseline, with no difference across groups.
170. In the largest experimental study of its kind, Allcott and colleagues randomized 1,661 Facebook users to an experimental condition of 4 weeks deactivation of their Facebook accounts or no change in use of social media. Those who deactivated their accounts reported more offline activities including time spent with family and friends. The intervention was associated with an improved sense of well-being and reductions in depression and anxiety. However, the effect sizes were small (e.g., .09 standard deviation for depression and .10 for anxiety, corresponding to an  $r=0.05$ ). The study was limited to adults aged 18 and older. Two similar studies, one involving 1,095 Danish adults (Tromholt 2016) and another involving 167 US undergraduate students (Mosquera et al. 2020) similarly showed beneficial effects of a one-week Facebook holiday on life satisfaction and depressive feelings.
171. A recent meta-analysis by Ramadhan and colleagues specifically reviewed experimental studies of social media restriction (what they called “social media detox”) (Ramadhan et al. 2024). These authors identified 10 studies that examined the effect of experimental studies of social media restriction on depressive symptoms, stress, well-being and life satisfaction. They found a significant reduction in depressive symptoms as a result of social media restrictions ( $d= -0.29$ , 95% CI= $-0.51, -0.07$ ;  $p=0.01$ ; equivalent  $r=-0.14$ )(see Exhibit E), whereas the effect on stress, well-being a life satisfaction were non-significant.
172. Overall, the results of longitudinal and experimental studies are consistent with a causal link between excessive social media use and mental health problems. These studies also point to specific mechanisms linking social media use with these adverse outcomes, including upward social comparison and sleep problems.

#### 4.4.5 Response to criticism that the association of social media use and depressive symptoms is small

173. There is a large degree of consistency among meta-analyses in finding the correlation between social media use and depression in adolescents to be in the  $r=0.11-0.13$  range. Some commentators have argued that because the correlation is in this range, the population effect of social media use on mental health problems is small (Ophir, Lipshits-Braziler, and Rosenberg 2020). The strength of the association was also one of Hill's guidelines. However, in discussing this criterion he also noted that we should not dismiss an association because it is too small. He used the examples of meningococcal meningitis and leptospirosis: few people harboring meningococcus develop meningitis and few people who are exposed to rat urine develop leptospirosis, suggesting that the effects are small in magnitude when examined in the population, but the association is clearly causal.
174. A more recent case in point is the association of air pollution with lung cancer. A meta-analytic study of 18 studies found a risk ratio of 1.09 (95% CI=1.04-1.14) for a 10- $\mu\text{g}/\text{m}^3$  change in exposure to  $\text{PM}_{2.5}$ , which means that a 10  $\mu\text{g}$  increase in  $\text{PM}_{2.5}$  particles (approximately equal to 1 standard deviation of the mean) increases the risk of lung cancer by 9%. This is a very small effect size (equivalent to  $r=0.03$ )(see Exhibit E), yet points to a major health risk (Hamra et al. 2014). The association of smoking with cancer is also in the small range. In a number of large longitudinal studies from Korea (Luu et al. 2022), Australia (Weber et al. 2021), and Japan (Inoue et al. 2004) the hazard ratios for cancers of smokers vs. non-smokers were in the 1.5-1.6 range, corresponding to correlation coefficients of around  $r=0.11-0.13$ . The effect of some of the common preventive interventions in medicine are similarly small. For example, Rosnow reports an  $r=0.03$  between taking Aspirin and reduction in the risk of heart attack (Rosnow 2003). It is also notable that about 25-30% of meta-analyses in psychology report an  $r$  of 0.11 to 0.13 or lower (Gignac and Szodorai 2016).
175. I attempted to estimate the practical importance of the magnitude of a correlation of 0.12 for the association of excessive social media use and depressive symptoms. This correlation coefficient translates to an OR of 1.55 based on the commonly used transformation formula (Borenstein et al. 2009). I also used numbers from a study conducted by my team using data from a representative general population survey of US adolescents (Riehm et al. 2019) to estimate the number of US children and adolescents whose significant internalizing problems can be attributed to excessive social media use (defined in this illustrative case as >3 hours per day).
176. A total of 20.7% of the adolescents in that survey reported using social media for >3 hours daily on average (Riehm et al. 2019). Approximately 26.8% of adolescents in the survey had significant internalizing problems (i.e., depressive symptoms) alone or in conjunction with significant externalizing symptoms. Based on these numbers and an OR=1.55, and assuming that the association is causal, the prevalence of significant internalizing symptoms among children and adolescents with >3 hours social media use is estimated to be approximately 34.0% compared to 24.9% in those using 3 hour or less. In other words, use of >3 hours of social media (compared to 3 hours or less) is associated with a 9.1% higher risk of significant internalizing symptoms (34.0% - 24.9% = 9.1%).

The computations for these estimates are shown in the Footnote.<sup>2</sup> Given that millions of adolescents are using these media, 9.1% increase in significant depressive symptoms is indeed concerning.

#### 4.5 Problematic use and unhealthy engagement with social media is associated with suicidal behavior

177. Suicidal behavior among youth is a major mental health and social concern not only because of lost years of life, but also because of the impact on families and peers. The rising trends in adolescent suicide in recent years in conjunction with the increased prevalence of depression, the most significant risk factor for suicide, has raised concerns about the social and psychological stressors that children are increasingly facing.

178. Several studies have examined the association between social media use and suicidal behavior. I could identify two meta-analyses of such studies (Huang 2022; Nesi et al. 2021). Authors of two additional reports conducted a systematic review of the literature but reported forgoing quantitative meta-analysis of the data because of the heterogeneity of studies (Macrynika et al. 2021; Sedgwick et al. 2019).

179. The meta-analysis by Huang was a general study that examined the association between social media use and depression, anxiety, and other internalizing symptoms as well as suicidal ideations (Huang 2022). Only three primary studies examining the association between social media use and suicidal ideations were included with a pooled correlation coefficient of 0.18 (95% CI=0.02-0.34). However, the meta-analysis was not limited to adolescents; the mean age of participants in these studies ranged from 13 to 50.1 years.

180. The Nesi and colleagues 2021 meta-analysis is the largest conducted so far examining the association of social media use with suicidal ideations and behavior (Nesi et al. 2021). These authors identified 61 primary studies that examined the association of social media use with self-injurious thoughts and behaviors. Although the primary studies included both studies of adults as well as studies of children and adolescents, the majority of studies included were limited to children and adolescents.

181. While much of the literature reviewed by Nesi and colleagues focused on the association between specific content (e.g., cybervictimization or viewing material related

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Footnote:

$$OR = 1.55 \approx \frac{\frac{0.34}{(1 - 0.34)}}{\frac{0.249}{(1 - 0.249)}} \quad \text{and} \quad 0.268 = (0.34 \times 0.207) + (0.249 \times [1 - 0.207])$$

The odds ratio of 1.55 is based on transformation of  $r=0.12$ ; 0.268 (26.8%) is the proportion of significant internalizing symptoms overall; .34 (34%) is the proportion with these symptoms in children and adolescents with >3 hours of social media use; 0.249 (24.9%) is the proportion with these symptoms in children and adolescents using social media for 3 hours or less and 0.207 (20.7%) is the proportion with >3 hours of social media use.

to self-injurious thoughts or behaviors) and suicidal ideations and behaviors, four studied (n=21391) examined the association of problematic (i.e., addictive) social media use with suicidal ideations. The pooled effect size in these four studies was also on par with the associations noted for cybervictimization and for social media use involving posting or viewing material related to self-injurious thoughts or behavior (OR=2.81; equivalent  $r=0.27$ ) (see Exhibit E).

182. A recent nationwide study of over 37,000 Norwegian adolescents in grades 8-11 conducted in 2017-2018 further supports the conclusions of these meta-analyses (Tormoen et al. 2023). The authors found a significant association between using more than 3 hours of social media per day and self-harm behavior (unadjusted odds ratio=2.74, equivalent  $r=0.27$ ; adjusted odds ratio=1.49, equivalent  $r=0.11$ ) (see Exhibit E). Self-harm was defined by the question: “Have you tried to harm yourself in the past 12 months?” Notably, the association was stronger in children and adolescents without depressive symptoms than those with depressive symptoms, suggesting that social media use is independently associated with such behavior. Self-harm behavior was rather common in this population (16.5%), as was use of social media for more than 3 hours per day (25.8%).

183. A second notable study examined the longitudinal association of screen time with suicidal behavior in over 11,000 US children aged 9-11 years who participated in the ABCD study (Chu, Ganson, et al. 2023). The authors examined associations for different types of screen time, including social media, as well as overall. Screen time was measured based on the validated ABCD Youth Screen Time Survey and suicidal behavior was assessed 2 years later using the Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS-5), a computerized tool based on the DSM-5. Suicidal behavior included passive suicidal ideations, nonspecific active suicidal ideations, active suicidal ideations with a plan/method/preparation/intent, and suicide attempts. The analyses found that every additional hour of social media exposure was associated with a 40% higher odds of suicidal behavior (OR=1.40, equivalent  $r=0.09$ ) (see Exhibit E), which was statistically significant. When the authors adjusted the analyses for a number of potential confounders, including baseline depression, the association was attenuated (adjusted OR=1.27, equivalent  $r=0.07$ ) (see Exhibit E) and reached a trend level of statistical significance ( $p=0.067$ ). The prevalence of suicidal behavior in this age group was rather low (1.4%). Further, depression at baseline might have been a mediator of the association of social media use and suicidal behavior, in which case it should not have been adjusted.

184. Overall, the results of the meta-analyses and large-scale studies reviewed portray a consistent association between problematic social media use with self-harm or suicidal ideations and behaviors. These findings are in line with the previously discussed associations of problematic social media use with depressive symptoms.

#### 4.6 Problematic social media use is causally associated with negative social comparison and body image disturbance

185. Even before the emergence of social media, there were concerns that exposure to beauty models with unnaturally thin or athletic body builds may impact adolescents’ and young adults’ body image (Rabak-Wagener, Eickhoff-Shemek, and Kelly-Vance 1998; Spillman and Everington 1989). Reports and epidemiological research studies had noted a

much higher prevalence of eating disorders in the Western countries where youth are more heavily exposed to media influences compared to non-industrialized countries (Jackson, Cai, and Chen 2020; Rubin et al. 2008).

186. Social media has heightened these concerns. However, there are several important differences between social media and traditional media that are relevant with regard to the risk of body image disturbance. First, unlike traditional media, social media users are not just recipients of content but also creators of content. Some platforms (e.g., Instagram, TikTok) are especially “visual,” encouraging users to post multiple pictures or videos and update them regularly. In 2016, it was estimated that over 3.2 billion new photographs were uploaded to social media every day (Mingoia et al. 2017). Choosing, editing, and posting pictures or videos to social media platforms is made quite easy with modern smart phones. Users can easily edit their pictures and videos to present an idealized identity and image on social media and to curate their online appearance to fit the “thin-ideal”. They may manipulate aspects of their appearance such as background and lighting or alter their appearance using filters. Thus, social media enables users to present an idealized version of themselves.
187. Excessive time spent on doctoring one’s pictures to fit the image ideal may be a hallmark of negative effects of social media (Vandenbosch, Fardouly, and Tiggemann 2022; Lonergan et al. 2020). A survey of over 4,000 Australian adolescents (aged 11-19 years) found that avoidance of posting selfies, photo investment (effort in choosing a selfie to post to social media, as well as monitoring responses to such image), photo manipulation, and investment in others' selfies is strongly associated with eating disorders (Lonergan et al. 2020).
188. In an experimental study of 144 adolescent girls (ages 14-18), Kleemans and colleagues investigated the effect of manipulated vs. unmanipulated Instagram photos on body image dissatisfaction (Kleemans et al. 2018). The authors also examined whether social comparison moderates this association. The participants were randomly exposed to either original or manipulated (retouched and reshaped) Instagram selfies of other girls. Photo manipulation was accomplished by using effects and filters that are available on Instagram and included removing eye bags, wrinkles, and impurities, and reshaping legs to be thinner and waist to be slimmer. Exposure to manipulated Instagram photos led to lower body image satisfaction (measured by Body Image State Scale) ( $r=0.17$ ). The effect was especially stronger among girls with higher social comparison tendencies ( $r=0.25$ ), compared to those with lower social comparison tendencies ( $r=0.0$ ). Social comparison tendencies were measured using a standardized measure. The authors concluded that “...exposure to manipulated Instagram photos indeed leads to lower body satisfaction in comparison to exposure to non-manipulated selfies from online peers. This particularly related to girls with a higher tendency to make social comparisons.” (p. 103)
189. A second important difference between social and traditional media is that users of social media regularly receive feedback on their profiles, pictures or videos. In some cases, these comments and feedback are critical or abusive. Not infrequently, youth whose appearance does not fit the idealized stereotype are bullied by their peers. Teasing about weight or appearance is a common theme for cyberbullying. While bullying in school is not a new phenomenon, the scale and exposure to the bullying is. Prior to social media,



bullying stopped when a student went home, but with the pervasiveness of social media, there is no such reprieve. Receiving these negative feedbacks to this extent and with this persistence is unique to social media.

190. A third difference between social media and traditional media is that users of social media are typically exposed to images and stories about their peers, friends or acquaintances, whereas traditional media typically presents images and stories about celebrities and others with whom the user is not intimately familiar. Comparisons with peers and friends on social media are likely more impactful than comparisons with out-of-reach celebrities or models on traditional media. There is also some limited evidence that the context of social media influences the impact of social comparisons. For example, in a study of 193 female first year college students who were randomly assigned to view a series of either Facebook or traditional media thin-ideal images, appearance comparisons were associated with increased body image dissatisfaction from before exposure to post-exposure only among those who were shown Facebook images (Cohen and Blaszczynski 2015). Content analyses have identified several social media trends including promotion of thinness and weight loss, diet, exercise, and lifestyle regimes.

#### 4.6.1 Unhealthy use of social media may be related to body dysmorphic disorder and eating disorders

191. Dissatisfaction with appearance is not limited to body shape and weight. Dissatisfaction with general appearance may extend to facial hair, height, and complexion, facial acne, and hair thinning. When these concerns are associated with obsessive thoughts and rituals such as skin picking, mirror gazing, excessive grooming, or mental acts such as constant comparison along with preoccupation causing significant distress or impairment in social, occupational, or other areas of functioning, these thoughts and behaviors may meet the criteria for body dysmorphic disorder--a psychiatric disorder in the diagnostic and statistical manual of mental disorders-fifth edition (DSM-5-TR). The DSM-5-TR notes that "Individuals with body dysmorphic disorder are preoccupied with one or more perceived defects or flaws in their physical appearance that are not observable or appear slight to others; this preoccupation often causes social anxiety and avoidance." (American Psychiatric Association 2022)
192. There is evidence of an association in youth between upward appearance comparison on social media and dissatisfaction with ones appearance (Yang et al. 2020). There are also indications that the prevalence of body dysmorphic disorder has increased in the wake of widespread use of social media (Barone, De Bernardis, and Persichetti 2023), especially the following the COVID-19 pandemic which was associated with increased use of social media (Vall-Roque, Andres, and Saldana 2021). The association may be mediated through use of filtering apps that allow for modifying and "doctoring" of pictures that adolescents post on social media platforms (Tiggemann, Anderberg, and Brown 2020).
193. Increased prevalence of body dysmorphic disorder is, in turn, associated with greater acceptance of cosmetic surgery. A 2019 survey of young adults found higher score on the Acceptance of Cosmetic Surgery Scale in users of Snapchat, Tinder, and social media photo filters (Chen et al. 2019). These findings were corroborated in future studies



(Beos, Kemps, and Prichard 2021; Ateq, Alhajji, and Alhusseini 2024). In a commentary on the Chen and colleagues paper, Reilly and colleagues note that the study's findings corroborate "the rising trend noticed among facial plastic surgeons" (Reilly, Parsa, and Biel 2019). Indeed, the rise of social media and use of face-editing apps has dramatically influenced the practice of cosmetic surgery. In a survey of patients seeking treatment at a private practice facial plastic surgery office, the majority of these patients confirmed that these apps played a role in pursuing cosmetic procedures (56.5%) (Othman et al. 2021).

194. In a paper titled "Is 'Snapchat dysmorphia' a real issue?", Ramphul and Mejias commented on media interviews by several cosmetic surgeons who had "encountered requests sounding similar to what a 'filtered' Snapchat picture would look like, with one plastic surgeon even having a patient who actually produced a 'filtered' image." (Ramphul and Mejias 2018).

195. Overall, research as well as reports by cosmetic surgeons support the view that the use of social media has contributed to an increasing prevalence of dissatisfaction with one's appearance and demand for cosmetic surgery. The relationship between use of social media and appearance dissatisfaction may be stronger in those using image filtering apps.

#### 4.6.2 Meta-analyses support the causal association of social media use with body image dissatisfaction

196. Several studies have examined the association of social media use with body image. This research has been summarized in several meta-analyses (Blanchard et al. 2023; de Valle et al. 2021; Huang, Peng, and Ahn 2021; Mingoia et al. 2017; Saiphoo and Vahedi 2019). The de Valle and colleagues' report was comprised of separate meta-analyses of different types of experimental and longitudinal studies that I detail below.

197. The meta-analysis by Mingoia and colleagues focused on the association between social media use and thin ideal internalization (Mingoia et al. 2017). This focus was motivated by the "tripartite influence model" which proposes that an internalized unrealistic body and appearance ideal is the mechanism through which exposure to media, either traditional or social media, leads to dissatisfaction with one's body or appearance and, in some cases, compensatory behaviors including dieting, excessive exercise, or eating disorders (Thompson et al. 1999). The authors identified 6 primary studies that included a measure of internalized "thin ideal". The measures of thin ideal internalization assess the extent to which the individual has adopted the unrealistic appearance presented to them in the social media (e.g., "I wish I looked like a model"). The average ages of participants in these studies ranged from 11.5 to 19.3 years (mean age in 5 of the 6 studies was less than 16 years). The studies were limited to female adolescent girls in high school. No publication bias was identified. In addition to examining the association with overall social media use, the meta-analysis also examined the association with appearance-related use (i.e., how often the participants engaged in appearance-related activities on social media such as frequency of viewing friends' photos, number of selfie images posted and time spent on viewing profiles or comments from other users). The meta-analysis found a correlation of  $r=0.18$  (95% CI=0.12-0.23) between social media use and internalization of thin ideal. The association was stronger for appearance-related use which was specifically measured in 4 of the 6 studies. In particular, the correlation coefficients for overall use

ranged from .12 to .18 across studies, whereas the correlation coefficients for appearance related use ranged from .17 to .36. The authors concluded that the use of social media is related to female body image internalization and that the association is stronger for exposure to and use of appearance-related content than for overall use.

198. The meta-analysis by Saiphoo and Vahedi included 63 independent samples. The age group of participants in the included studies ranged widely from a study with mean age of 11 to another with mean age of 34 years (Saiphoo and Vahedi 2019). The measure of social media exposure in most studies was based on the number of hours per day that the participant spent using social media. While some studies examined negative body image in general, in addition to body image some studies included behavioral aspects related to body image dissatisfaction (i.e., abnormal eating behavior). Also, some studies examined specific forms of social media use such as appearance-focused use (e.g., making appearance-based social comparisons). Almost all studies used standard validated measures of body image disturbance. The authors did not find any publication bias. The pooled correlation between social media use and body image disturbance in this study was  $r=0.17$  (95% CI=0.13-0.21). Sixteen studies that assessed “appearance-focused” social media use found a stronger effect ( $r=0.31$ ). Also, the association was stronger in studies with a lower mean age of participants, although the authors did not compute separate effect sizes for studies of adolescents. Surprisingly, gender was not a significant moderator of the effect, suggesting that the effect of social media use on body image did not differ among males and females.
199. Because the impact of social media use on body image is especially pertinent for adolescents and because Saiphoo and Vahedi found a significant moderating effect for age but did not report separate effect for adolescents, I extracted data on studies with mean age <18 years from the Saiphoo and Vahedi study and conducted a separate random-effect meta-analysis to estimate the pooled effect in this age group. This analysis was limited to 21 studies in which the mean age of participants was less than 18 years. The pooled correlation from these studies was  $r=0.21$  (95% CI=0.15-0.27) which is larger than the pooled correlation for all 63 studies in Saiphoo and Vahedi meta-analysis. For a detailed description of this meta-analysis conducted by me and its results, please see **Exhibit D**.
200. As noted, the meta-analytic report by de Valle and colleagues is in fact comprised of 4 separate meta-analyses for 3 different types of primary experimental studies and for 1 type of longitudinal studies (de Valle et al. 2021). The report is based on 45 primary studies overall. The mean age of participants in experimental studies was 21.5 years (range=15.9-26.8 years). The mean age across longitudinal studies was 14.8 years (range=10.5-18.7). Experimental samples typically comprised college students or young adults, whereas most longitudinal studies were comprised of high school students.
201. The 3 categories of experimental studies included a category of studies that compared viewing appearance-ideal images vs. viewing non-appearance related posts (category 1). This category included 24 experiments. Appearance ideal stimuli included a range of possible images, such as “attractive” people or people meeting fitness or thinness ideals. The comparison condition was unrelated to appearance (e.g., nature or travel images).

202. A second category of studies in the de Valle and colleagues' report compared viewing appearance-related ideal images in higher risk context vs. in lower risk context (category 2). Both the experimental and comparison stimuli in this category included appearance-ideal images, but the features (e.g., captions, accompanying images, comments, slogans, "likes" and "follows") surrounding the images in the "high risk" experimental arm were designed to increase the risk of a negative body image. For example, the image may be associated with a comment praising the person's appearance. Whereas in the control arm, appearance-ideal images were accompanied by features intended to decrease the negative effect of the images (e.g., body-positive captions). This category included 21 experiments.
203. Finally, a third category of experimental studies in the de Valle and colleagues' report compared viewing appearance ideal images vs. other appearance images (category 3). These other appearance images were deemed to be less damaging to body image (e.g., images of average or plus-sized people or un-edited images). This category included 14 experiments. The total number of experiments is larger than the number of studies in the report because some primary studies included more than one experiment.
204. The fourth meta-analysis in the de Valle and colleagues' report was a meta-analysis of longitudinal studies. These studies simply assessed the association of social media use with body image at a later point in time. The follow-up times ranged from 4 weeks to two years. These comparisons included 10 samples. There was no publication bias in the meta-analysis after excluding outlier studies.
205. Because comparisons in categories 1-3 involved comparing two arms (the experimental arm and the control arm), the effect sizes were computed as Hedge's  $g$  (difference between means of the two groups divided by the pooled standard deviation of these groups). These effect sizes can be converted to each other or other measures of association. For consistency with other effect sizes presented in this report, I also computed and report approximate  $r$  equivalents of these measures based on standard formulas (Borenstein et al. 2009). For formulas see Exhibit E.
206. After removing outliers, the category 1 experiments produced a small but significant association (Hedge's  $g = -0.28$ , 95% CI =  $-0.35, -0.20$ ; equivalent  $r = -0.14$ , 95% CI =  $-0.17, -0.10$ ) (see Exhibit E). A negative effect size in this context indicates poorer body image in the experimental group compared to the comparison group.
207. The effect size in the category 2 comparisons was smaller but still significant (Hedge's  $g = -0.12$ , 95% CI =  $-0.20, -0.04$ ; equivalent  $r = -0.06$ , 95% CI =  $-0.10, -0.02$ ) (see Exhibit E).
208. The effect size for category 3 comparisons after the authors removed 2 outliers was in line with Category 1 studies (Hedge's  $g = -0.29$ , 95% CI =  $-0.40, -0.18$ ; equivalent  $r = -0.14$ , 95% CI =  $-0.20, -0.09$ ). Of note, it is customary to remove outlier studies from meta-analyses as they indicate chance variations or variations due to unusual study sample or design.

209. Overall, findings from these studies indicate that exposure to appearance-ideal images is detrimental to body image. Furthermore, the similarity between category 1 and 3 results indicate that it is appearance ideal images that are harmful rather than appearance images more generally. Category 1 included “non-person” images of travel or nature as the control arm and category 3 included images of average or plus-sized people or un-edited images as the control arm. As such, “person” images that are not appearance ideal are associated with the same change in body image as non-person images. On the other hand, results of category 2 studies imply that changing the context in which the images are presented, and the accompanying messages, may have a small effect in countering the negative effects of appearance ideal images.
210. The authors of the meta-analysis discuss two caveats regarding interpreting their results. First, the appearance ideal images presented in these experiments were images of people who were unknown to participants. Users of social media are often exposed to images of their peers or friends. Exposure to peers’ and friends’ appearance ideal images may be more impactful on the users’ body image, and the authors recommend that clinicians counsel clients to reduce exposure to them as well as increasing their social media literacy and awareness of how posts are modified and selected. Second, the experiments were based on short exposure to appearance ideal images. Users of social media are often exposed to these images for prolonged periods. Both these caveats suggest that the real-world impact of exposure to appearance ideal images may be larger than identified in these studies.
211. The fourth meta-analysis in de Valle and colleagues’ report was a meta-analysis of 10 longitudinal studies. This meta-analysis also identified a small but significant negative effect of social media use on body image (Fisher’s  $Z = -0.08$ , 95% CI =  $-0.11, -0.06$ , equivalent  $r = -0.08$ , 95% CI =  $-0.11, -0.03$ ) (see Exhibit E). The time lag between measurement of social media use and body image assessment varied between weeks to years across different studies. But variation in time lag was not associated with larger or smaller effects, nor was the type of social media use (quantity of social media use overall vs. measures of exposure to images of other persons). The authors note that the number of longitudinal studies was limited.
212. Overall, de Valle and colleagues concluded that viewing appearance-ideal images on social media is detrimental to the body image of users.
213. The meta-analysis by Huang and colleagues was not limited to social media use (Huang, Peng, and Ahn 2021). Rather, it examined the relationship between media exposure overall with body image outcomes. However, the analyses also examined the effect of type of media, including social media. Of 130 studies included, only 4 were based on social media. This is perhaps due to the limited search terms used in this meta-analysis—the only terms used in the search were “media” and “television”. Other meta-analyses had used much wider terminology, including names of specific social media platforms. The meta-analysis differentiated between studies examining exposure to celebrity vs. non-celebrity social media accounts. A significant association was found between exposure to non-celebrity accounts and negative body image outcomes (Hedge’s  $g = -0.20$ , 95% CI =  $-0.54, -0.10$ ; equivalent  $r = -0.10$ , 95% CI =  $-0.26, -0.05$ ) (see Exhibit E).

214. Overall, the meta-analyses I reviewed are consistent in finding an association between exposure to social media and negative body image outcomes. This effect is seen both in non-experimental (cross-sectional and longitudinal) studies as well as in experimental studies. There is also some evidence that internalization of thin ideals and social comparison are important mechanisms for this effect.

215. In addition to the consistency of the relationship in multiple studies, temporal order (established in longitudinal studies) and experimental evidence, analogy (another of Hill's guidelines) with the effect of traditional media on body image is also supportive of a causal link between social media exposure and body image outcomes. A large body of research has consistently documented an association between traditional media exposure to appearance-ideal images and body image dissatisfaction (Thompson et al. 1999; Grabe, Ward, and Hyde 2008). However, studies show that social media is a substantial contributing factor in increasing the risk of eating disorders even in the presence of traditional media messaging (Fardouly, Pinkus, and Vartanian 2017; Cohen and Blaszczynski 2015; Bair et al. 2012).

#### 4.6.3 Industry's own research on social comparison and body image dissatisfaction

216. Research conducted by Facebook and Instagram researchers is generally consistent with academic research. For example, documents leaked by the Facebook whistleblower Frances Haugen include a 2020 report by Instagram investigators that focused on the prevalence and negative impact of social comparison (Haugen\_00015958). This leaked report states that "66% of teen girls on Instagram experience negative social comparison (compared to 40% of teen boys)", that "52% of teen girls who experienced negative social comparison on Instagram, said that it was caused by images related to beauty" and that "32% of teen girls said that when they felt bad about their bodies, Instagram made them feel worse" (Haugen\_00015958 at Haugen\_00015967). In the executive summary of the report which was based qualitative interviews with adolescent and young adult participants, the authors wrote that "social comparison journeys mimic the grief cycle. Pre-existing moods are a precursor to a downward emotional spiral, encompassing a range of emotions from jealousy to self-proclaimed dysmorphia" (Haugen\_00015958 at Haugen\_00015964)..

217. A 2021 survey by Instagram investigators supported these conclusions (Haugen\_00007080). In this survey of over 50,000 participants from 10 countries, 33% of Instagram users stated that "they compare their appearances to other's often or always. Nearly half (48%) of teen girls do." (Haugen\_00007080 at Haugen\_00007082). The report also found that such comparison causes people to "feel bad about themselves" (Haugen\_00007080 at Haugen\_00007082). More than a third (37%) of girls reported often or always seeing posts that make them feel worse about their bodies (Haugen\_00007080 at Haugen\_00007082). This survey also identified the relationship between content of viewed posts and negative social comparison. Participants who reported seeing a greater proportion of content about fashion (including beauty) and relationships were more likely to feel bad about their bodies and appearance (Haugen\_00002527 at Haugen\_00002529). These posts comprised a third of what teen girls saw on Instagram (Haugen\_00002527 at Haugen\_00002529).



218. Other research by Instagram investigators has similarly shown that social comparison is quite common among youth, an intense experience and potentially made worse by use of Instagram. In an international survey of over 22,000 Instagram users across the United States, Japan, Brazil, Indonesia, Turkey and Brazil, conducted by Instagram investigators, the participants were asked about the hard moments they had experienced in the past 30 days (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095011)). Next, they asked these participants about the intensity of this experience (how bad it made them feel?) and the impact of Instagram use on this experience (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095011)).
219. Among teens in this survey, social comparison (57.6%) and body image dissatisfaction (55.6%) were among the most common issues. (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095015)). Social comparison was assessed by the question: “Have you frequently felt bad about yourself after comparing yourself to someone else?” and body image dissatisfaction was assessed by the question: “Have you frequently disliked the way your body looks?” (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095012)).
220. Social comparison was also among the most intense experiences, in second place in terms of intensity after suicidal ideations. (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095017)). Slightly less than half of teenagers also reported eating problems (“Have you felt that you have an unhealthy relationship with food?”) (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095012, META3047MDL-003-00095015)). A third of teenage girls thought that Instagram made body image dissatisfaction worse (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095021)).
221. Similarly, a sizeable group of teenagers thought that Instagram use made social comparison worse (20.1% among teenage girls and 10.1% among boys) and 17.0% of girls vs. 6.7% of boys thought that Instagram made eating problems worse (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 21(META3047MDL-003-00095008 at META3047MDL-003-00095021)).



222. Of note, in a series of annotations on this study, Facebook sought to highlight several limitations. For example, they noted that “The description of these area categories (e.g., “mental health”) were perception-based, did not involve a clinical assessment, and did not use clinical criterion.” They also wrote: “As discussed throughout, this research did not measure whether Instagram makes things worse but how people who reported that they were already experiencing these issues felt Instagram impacted their experience.” (Instagram Research Deck – Hard Life Moments – Mental Health Deep Dive
223. <https://about.fb.com/wp-content/uploads/2021/09/Instagram-Teen-Annotated-Research-Deck-1.pdf>, at p. 18) These criticisms are beside the point. Most research in behavioral health is based on self-reporting by individuals on their experiences. Most of the diagnostic categories in the DSM-5 are based on experience of symptoms.
224. Some other concerns raised in the annotations are valid. For example, they noted that sample sizes for some questions were small (e.g., fewer than 150 teen girls spread across the six countries answered questions about their experience of body image and Instagram), and the analyses did not adjust for country and for non-response. Yet, the annotations go on to note: “We are taking away from the research that social comparison/body image issues are important issues for users and this is informing our path forward with respect to our product as we consider ways to help teens cope with these hard life moments.” (Instagram Research Deck – Hard Life Moments – Mental Health Deep Dive
225. <https://about.fb.com/wp-content/uploads/2021/09/Instagram-Teen-Annotated-Research-Deck-1.pdf>, at p. 21) While this study has limitations, it is still indicative that the social media platform was harming teen girls in terms of body image and social comparison. Overall, these limitations do not significantly impact my general conclusion that the industry’s own research supported academic research in finding a link between social media and body image dissatisfaction.
226. The research by Instagram investigators has also shown that the negative feelings induced by social comparison are often long-lasting. In a survey and qualitative study conducted in 2018 these investigators found that 33% of participants who reported upsetting feelings caused by negative social comparison were feeling so for “several months to a year” (Haugen\_00000797 at Haugen\_00000877).
227. Depositions by social media executives also indicate that the impact of social comparison on body image dissatisfaction was well recognized within social media companies. For example, a review of literature on selfie manipulation, also known as “beautification” or “cosmetic surgery effects” (changes in appearance that normally can only happen through cosmetic surgery) commissioned by Instagram concluded that allowing these manipulations through selfie filters can

“...risk propagating unrealistic standards of beauty that are not only harmful, but divide more than they unite. Whether adolescents and young women are from Asia, America or Australia, studies indicate they are all engaging in photo-editing to achieve unachievable beauty standards in response to continuous feedback that they, as they are, are not “good enough” (Chae, 2017; Chua and Chang, 2016, Fox & Vendemia, 2016; Mclean et al., 2015). This in turn only perpetuates and

exacerbates risk for body dissatisfaction, eating disorder behaviors, depression and anxiety across the globe (Thompson et al., 1999; Grabe et al., 2008).” (Deposition of Margaret Gould Stewart, October 21, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 10 (META3047MDL-014-00376297)).

228. Following public complaints and regulatory questions, Instagram implemented a ban on cosmetic surgery effects in October 2019 (Deposition of Margaret Gould Stewart, October 21, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 6 (META3047MDL-003-00179481)). In further consultations with 21 experts from around the globe in December 2019 the company decided to continue the ban (Deposition of Margaret Gould Stewart, October 21, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 6 (META3047MDL-003-00179481 at META3047MDL-003-00179482)). In an email to Mark Zuckerberg, the CEO of Meta dated May 12, 2020, Ms. Stewart, the then Facebook VP of Product Design and Responsible Innovation appealed for an extension of the ban:

“As a parent of two teenage girls...I can tell you the pressure on them and their peers coming through social media is intense with respect to body image. I recognize that my family situation makes me somewhat biased but it also gives me first hand knowledge that most of the people looking at this issue don't have. There won't be hard data to prove causal harm for many years, if ever, but I was hoping we could maintain a moderately protective stance here given the risk to minors (Deposition of Margaret Gould Stewart, October 21, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 8 (META3047MDL-014-00377295)).

229. In her deposition, Ms. Stewart further elaborated her concerns:

“My concern was that if a product was encouraging or proactively presenting opportunities to in quote "improve your appearance," that over time logically that would send a message to anyone that their appearance naturalistically was not okay as it is, and that that -- that's a concern for all people, but it's particularly concerning to minors who are going through a vulnerable period in their lives through adolescence.” (Deposition of Margaret Gould Stewart, October 21, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), at 47:25-48:9).

230. In another set of messages with her colleagues at Meta, Ms. Stewart further explained her concerns:

“I can tell you as someone who spends a LOT of time with teenage girls, both in my own home and through the high schools, it seems patently obvious that phone usage, selfie-culture, and photo editing are contributing to anxiety, depression, and body dysmorphia. While we may not have a smoking gun on the cause, I think we have to assume we are contributors/amplifiers and tread very carefully on anything that further contributes.” (Deposition of Margaret Gould Stewart, October 21, 2024,

In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 15 (META3047MDL-014-00360058).

231. However, the company ultimately decided to lift the ban after Ms. Stewart's email (Deposition of Margaret Gould Stewart, October 21, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), at 56:15-18).

232. The internal research conducted by Wendy Gross and her colleagues supports her conclusions. In a qualitative study involving focus groups and in-depth interviews with teens in the US and UK commissioned by Instagram (5 focus groups in each country), these teens identified social media apps as the culprit for their generation's increased rates of depression, anxiety and other mental health problems (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 9 (META3047MDL-003-00091414 at META3047MDL-003-00091443)) They also noted the especially harmful effect of social comparison among vulnerable adolescents:

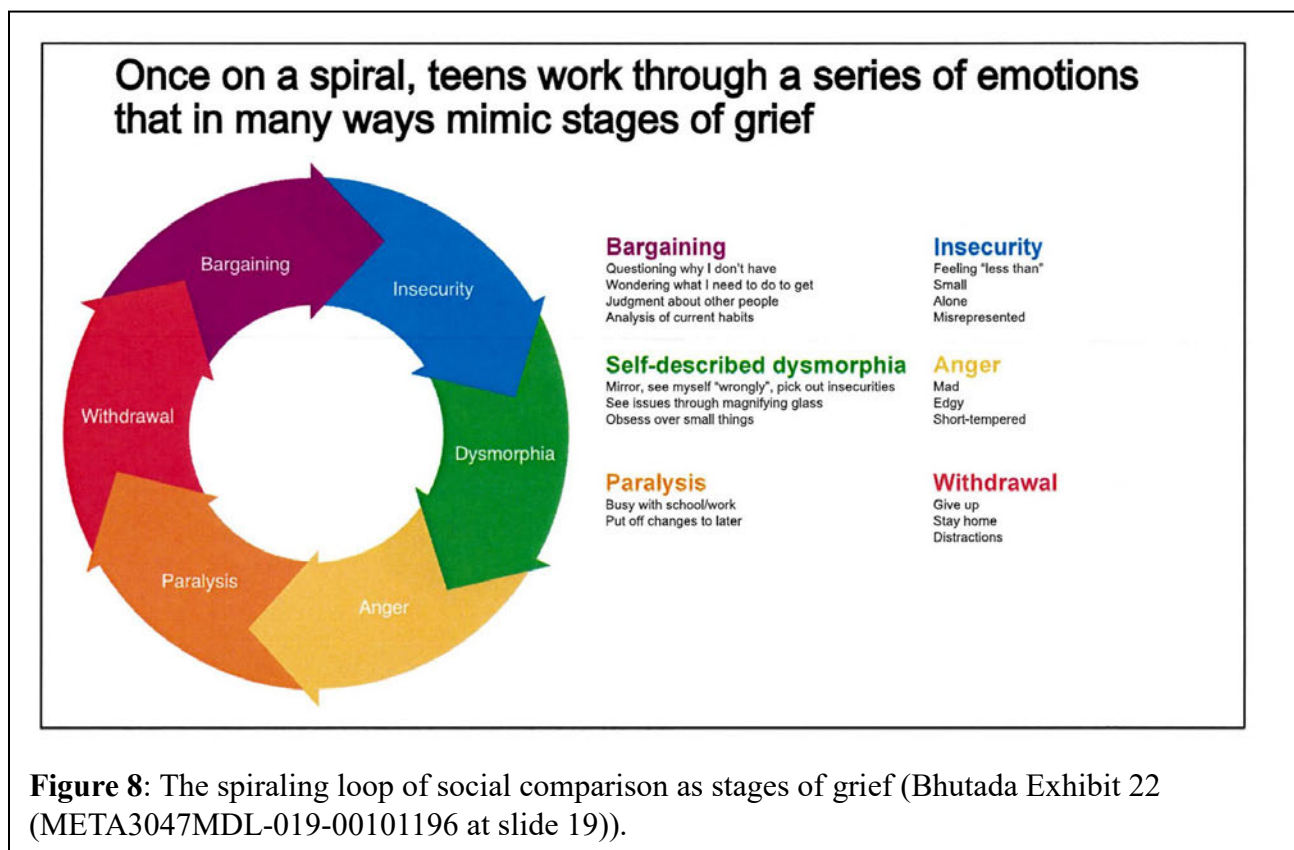
"Underlying emotional states play a key role in a young person's ability to deal with the content they see. If they are having a bad day, they know they are more vulnerable to what they see online...This was particularly true for social comparison. The more a young person is feeling bad, the more vulnerable they are to negatively comparing themselves to others." (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 9 (META3047MDL-003-00091414 at META3047MDL-003-00091425))

233. The teens also identified a negative feedback or spiraling loop: the worse they felt about themselves, the more they engaged with the platform and compared themselves with others in their circle and tried to conform to social pressures, leading to more social comparisons and negative input (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 9 (META3047MDL-003-00091414 at META3047MDL-003-00091445)).

234. In one of the internal presentations by these investigators it was noted that the negative comparison spiral is akin to stages of grief (**Figure 8**). The presentation goes on to say that the "Users' experience of downward spiral is exacerbated by our platform" (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 22 (META3047MDL-019-00101196 at slide 20)). The presentation further noted that "Pre-existing moods are a precursor to a downward emotional spiral" (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 22 (META3047MDL-019-00101196 at slide 20)). Specifically, the "Pressure to look perfect" and "Highlight reel norm" were pointed out as the culprits (Deposition of Shruti Bhutada, Volume I, November 18, 2024, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 22 (META3047MDL-019-00101196 at

slide 20)). The latter refers to posting of pictures that present the best moments (i.e., highlights) of members.

235. Further research by Meta researcher Dr. Wendy Gross and colleagues highlighted the high prevalence of social comparison in teens and young adult users of Instagram in both the US and UK. In a series of surveys and qualitative studies conducted during the COVID pandemic these investigators found that more than half of these young people regularly engaged in social comparison, and these comparisons most commonly focused on “looks” (64% in the US and 59% in UK focused on looks) (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 15 (META3047MDL-019-00093564 at slide 14)). Furthermore, social comparison regarding looks were frequently negative (50% in UK and 39% in the US). (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 15 (META3047MDL-019-00093564 at slide 18)).



#### 4.7 Social media use causes sleep disturbance

236. While some research has examined sleep problems as a mediator of the association between excessive or problematic use of social media and adverse mental health outcomes (Viner et al. 2019), studies have also examined sleep disturbance as an

adverse health outcome in its own right, especially among youth. The amount of sleep adolescents get has decreased in recent years (Twenge, Krizan, and Hisler 2017), which is attributed to increased use of social media apps on mobile phones (Hisler, Twenge, and Krizan 2020; Twenge, Hisler, and Krizan 2019).

237. The association of screen time with insomnia may be partly driven by shortened duration of sleep because of the time spent on social media apps at night or due to delayed initiation of sleep (Hale and Guan 2015). Exposure to light on mobile phones at bedtime is likely a driver for delayed initiation of sleep (Chang et al. 2015). Exposure to bright light before sleep leads to decreased melatonin release and increased wakefulness (Wood et al. 2013).
238. Several meta-analyses examined the association between sleep quality and smartphone use, which is the main way children and adolescents access social media (Alzhrani et al. 2023; Chu, Oh, et al. 2023; Kheirinejad et al. 2022; Maurya et al. 2022). The results of these studies consistently show an association between smartphone use and sleep problems. However, most of these studies did not specifically examine the effect of social media use and few used objective measures of smartphone use.
239. A recent meta-analysis that separately examined the association of different forms of digital media use with sleep problems categorized primary studies based on the type of digital media (Han 2024). The meta-analysis found associations between sleep problems and both excessive use of social media ( $r=0.28$ , based on 6 primary studies) as well as problematic use of social media ( $r=0.35$ , based on 11 primary studies). No evidence of publication bias was found in this meta-analysis.
240. Sleep problems are not only an adverse health outcome of excessive or problematic social media use; they may also act as mediators for other adverse outcomes such as depressive symptoms. In a large scale study based on the British Our Future cohort, 12,866 adolescents aged 13-16 years were sampled and interviewed 3 times (Viner et al. 2019). Frequent use of social media (multiple times daily) was associated with future distress measured by the 12-item General Health Questionnaire (GHQ) and self-ratings of anxiety. The potential mechanisms for this relationship were also investigated including inadequate sleep and low physical activity as well as cybervictimization. Inadequate sleep, defined by less than 8 hours of sleep on weekdays, was one of the mediators linking excessive use of social media with distress and anxiety one year later. Thus, at least part of the effect of excessive social media use on mental health outcomes is due to its replacing other normal activities of these youth, including cutting sleep.
241. Overall, studies consistently show the negative impact of social media use on sleep quality and quantity. Furthermore, sleep problems may be a mediator for other adverse mental health outcomes of excessive or problematic use of social media.



#### 4.8 Youth with pre-existing mental health problems are especially vulnerable to adverse effects of social media

242. As noted earlier, not all children and adolescents are similarly vulnerable to the effects of social media. One such group is adolescents with pre-existing mental health problems. Some past studies have specifically examined the mental health impact of social media use among youth with pre-existing mental health conditions, and at least two narrative reviews of this research have been published (Kostyrka-Allchorne et al. 2023; Caron et al. 2024). Both reviews noted potential positive aspects of social media use in this population by facilitating communication with peers, but both also noted special vulnerabilities among some of these adolescents.

243. For example, in a study of 433 psychiatrically hospitalized adolescents (aged 11–18 years), Nesi and colleagues found that while many of these children reported receiving emotional support through social media, many others reported negative emotional experiences (Nesi, Wolff, and Hunt 2019). More than a third (37.4%) reported having compared themselves negatively to others on social media and 30.7% felt left out or excluded. These experiences were more common among girls compared to boys. In addition, among both boys and girls, youth with internalizing diagnoses (e.g., depression) were more likely to report having compared themselves negatively to others and having felt excluded. A small percentage of youth had viewed content encouraging suicide (14.8%) or self-injury (16.6%); these behaviors were particularly common among youth with internalizing disorders and/or a lifetime history of suicide attempts.

244. Another study from Ireland compared hospitalized adolescents, those receiving care in outpatient settings and community-dwelling adolescents with and without mental health problems (Mullen, Dowling, and O'Reilly 2018). In total, 299 young people aged 12–18 years completed an online survey which included standardized questionnaires and questions about use of all forms of internet activities, including use of social media platforms. Almost all these adolescents used one or more social media platform. Compared to community dwelling adolescents who screened negative for mental health problems, those who screened positive and those attending inpatient or outpatient mental health services had more problematic social media use and reported more cyber-victimization.

245. A more recent study of 64 hospitalized adolescents found that being the subject of online rumors, illicit photographs, and threatening messages increased the risk of nonsuicidal self-injury, suicidal ideation, and suicide attempts in these adolescents (Lanzillo et al. 2023). Endorsement of any history of cyberbullying was significantly associated with non-suicidal self-injury. Remarkably, adolescents who were the victims of online rumors were over fifteen times more likely to engage in such self-injury behaviors, and all participants who reported being victimized by posting of illicit photographs endorsed such behavior. Similarly, participants who reported being the subject of online rumors were nearly seventeen times more likely to report suicide attempts.

246. A meta-analysis that reviewed studies examining the association of social media exposure with eating disorders also found that pre-existing body image vulnerabilities (e.g., shame and low self-esteem) predicted maladaptive interactions with social media and heightened susceptibility of eating disorder pathology (Dane and Bhatia 2023). Further,



high-risk individuals with elevated eating disorder scores on standardized questionnaires or a pre-existing eating disorder were more inclined to seek out damaging content on social media (such as “thinspiration” or weight loss) and they might have been more susceptible to internalization and social comparison, which in turn increase the risk of further clinical / subclinical eating disorders (Dane and Bhatia 2023).

247. A concerning development is the emergence of social media algorithms that select content according to the pre-occupations of individuals with pre-existing mental health vulnerabilities. A case in point is the TikTok’s algorithms that deliver increasingly targeted content related to body image and eating patterns to youth with eating disorders. In a recent study Griffiths and colleagues investigated the potential for these algorithms to exacerbate eating disorder symptoms by analyzing 1.03 million TikTok videos delivered to 42 individuals with eating disorders (76 % anorexia nervosa) and 49 healthy controls (average age 20.6 years) over a one-month period (Griffiths et al. 2024). Within these videos the investigators identified four video categories relevant to eating disorder: appearance-oriented videos, dieting videos, exercise videos, and toxic eating disorder (i.e., content that explicitly and unequivocally glorified and encouraged eating disorders and extreme dieting). Algorithms belonging to users with eating disorders delivered more appearance-oriented (+146%), dieting (+335%), exercise (+142%), and toxic eating disorder videos (+4343%). Of greater concern, among users with more severe eating disorder symptoms, the proportion of these videos was higher. This pattern was not explained by the users’ reactions to the algorithms (e.g., by “liking” them more often than the other users). The passive behaviors of the users such as more time spent watching a video or delays in skipping videos seemed to be driving delivery of this content. The investigators commented:

“In the context of eating disorders, our concern is that a vulnerable person may spend slightly more time watching a problematic video, or delay skipping over a problematic video, because it touches upon insecurities and briefly intensifies anxiety or other negative mood states (e.g., guilt) and/or induces an unfavourable appearance comparison.” (p. 9)

248. The investigators concluded that their results provide preliminary evidence that these algorithms might exacerbate eating disorder symptoms via algorithmic processes.
249. While socializing through social media may provide opportunities for some adolescents who have difficulty in creating in-person social connections, such as adolescents with autistic spectrum disorders or other developmental disabilities (Gillespie-Smith et al. 2021), social media use among these children and adolescents also poses special challenges. Certain personal dispositions or usage patterns can lead to negative outcomes, such as increased loneliness or decreased well-being in this population (van Asselt-Goverts et al. 2015). Some research has found that social media users with autism spectrum disorders experienced more online harassment than neurotypical populations (Fridh et al. 2018; Cook et al. 2017). For instance, in surveys of parents of children with and without autism spectrum disorders, Macmillan and colleagues found that autistic children experienced significantly more online risks than non-autistic children (Macmillan et al. 2020).

250. A qualitative study of young adults with autism spectrum disorder, their parents and case workers, found that these users had difficulty deciding how to react and respond to social media content (Page et al. 2022). They were anxious when they did not understand the emotions and intentions around what others posted on social media. The researchers noted that

“...even small decisions, mishaps, and misinterpretations negatively impacted our Autistic participants a great deal. After what they perceived as a major misstep on social media (e.g. inadvertently offending someone), some participants took drastic measure, including avoiding all service programs or isolating themselves at home for weeks. This reaction compounded the social isolation that was already difficult to overcome for these individuals. Since social anxiety is a frequently co-occurring symptom of being on the Autism spectrum.” (Page et al. 2022)

251. Another source of anxiety for these young people was misinterpretation of social media connections as literal friendships which sometimes made others uncomfortable or left the users vulnerable to risk. (Page et al. 2022)

252. In line with these studies, a comprehensive review of 5 qualitative and 21 quantitative primary studies of adolescents with depression, eating problems, non-suicidal self-injury and other emotional health conditions by Kostyrka-Allchorne and colleagues also found evidence for specific vulnerabilities to social media harms in these users with pre-existing conditions (Kostyrka-Allchorne et al. 2023). Based on this evidence, the authors concluded that “adolescents with clinical-level mental health difficulties may be more vulnerable to digitally mediated harm compared with peers, who do not have mental health difficulties” (Kostyrka-Allchorne et al. 2023).

## 5 POTENTIALLY HARMFUL FEATURES OF SPECIFIC SOCIAL MEDIA PLATFORMS

253. Most studies of the detrimental effects of excessive social media use did not distinguish between different platforms. This is justified because many children and adolescents use more than one platform and there are significant similarities between these platforms. Nevertheless, some studies have either focused on the effect of using specific platforms, especially more recent image-based platforms, or attempted to distinguish between these platforms. Two aspects of the newer platforms justify specific attention to these platforms: 1) The greater potential of image-based platforms to contribute to body image comparison and dissatisfaction and therefore, disordered eating behavior, and 2) The greater potential of some newer social media platforms to promote immersive use by aggressive algorithmic targeting. Below I present the results of some of the studies that focused on these specific effects.

### 5.1 The new image-based platforms are causally associated with body-image dissatisfaction

254. Some research suggests that image-based platforms may contribute to greater body image comparison (Engeln et al. 2020), body image dissatisfaction and eating disorders (Sanzari et al. 2023). The study by Sanzari and colleagues specifically compared two cohorts of US college students, one from before the COVID-19 pandemic (2015) and

another from after the pandemic (2022). Participants in 2022 reported both more use of social media and greater body image disturbances, more frequent vomiting and laxative use, and more time spent on a greater number of social media accounts. Further analyses suggested that exposure to weight loss content was associated with lower body appreciation, fears of negative appearance evaluation, and more frequent binge eating after controlling for gender and body mass index. Interestingly, exposure to body positivity/neutrality content did not have a protective effect against body dissatisfaction and disordered eating behaviors.

255. The impact of Instagram on body image dissatisfaction was borne out by the company's internal research as well. In a survey of 1000 adolescents conducted in 2019 by Instagram, adolescents reported being significantly more likely to experience negative social comparison on Instagram than on other apps (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Dr. Wendy Gross' deposition, Exhibit 6 (META3047MDL-014-00255333 at slide 44)). Almost a third of participants (32%) reported experiencing negative social comparisons on Instagram, whereas the rate of negative comparisons on other apps ranged from 10% (YouTube) to 21% (TikTok) (Deposition of Wendy Gross, PhD, January 28, 2025, In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation (MDL 3047), Exhibit 6 (META3047MDL-014-00255333 at slide 44)).

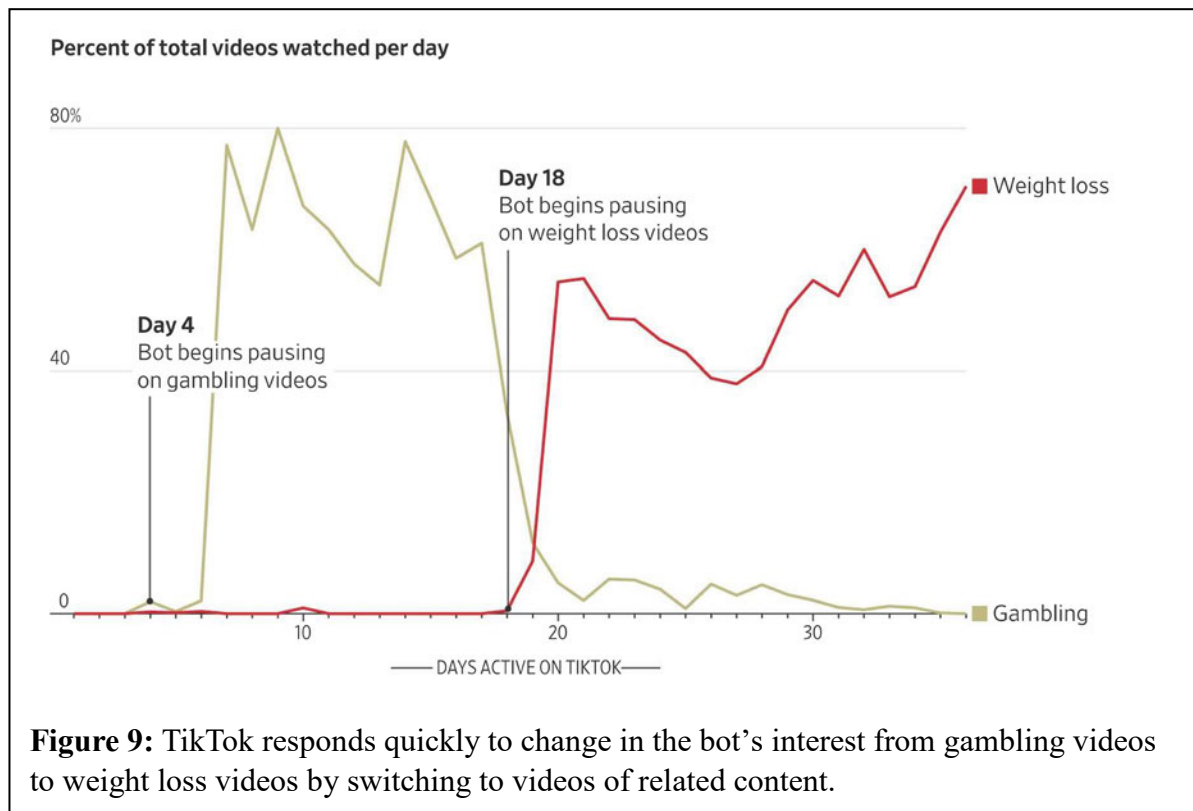
256. Instagram and TikTok offer users the opportunity to create and upload brief videos. Many of the videos on TikTok are playback videos to pop-songs—the so-called “LipSync” Videos. Like other social media posts, peers have the opportunity to react to posts by “liking” them or commenting on them. TikTok users can also call out “challenges” where viewers are encouraged to engage in a specific behavior which is often unpleasant (e.g., emptying a bucket of cold water on head) and at times dangerous (e.g., taking large amounts of an over-the-counter medication or herbs with psychoactive effects).

257. In addition to the rapid growth and spread of these media among teens, algorithmic features, including personalization of feeds based on how likely the recipient is to interact with the feeds, as well as the highly immersive nature of the apps, distinguish them from other social media apps. These features are designed to capture the attention of users and immerse them in the app thus keeping them on the app for a longer period. I briefly discuss these algorithmic features, using TikTok as an exemplar, and how they may potentially contribute to the apps' harms below.

## 5.2 Algorithmic targeting is an important factor in the development of problematic use

258. The rapid personalization of TikTok video feeds and their potential harmful effects was highlighted in a 2021 investigative report by Hobbs and colleagues in *Wall Street Journal* (Hobbs, Barry, and Koh 2021). The authors automatically opened a dozen accounts by bots which registered as 13-year-old adolescents. The algorithm very quickly identified the bots' “interests” based on videos searched and “favorited” or how long the bots paused on each video. To test the impact of the algorithm they programmed one bot to first show interest in gambling videos and then switch its interest to weight loss videos (**Figure 9**).

The TikTok algorithm “learned” and responded very quickly to this change in interest and switched the types of videos offered to the bot.



259. Overall, the bots received tens of thousands of weight-loss videos within weeks of subscribing to the app. Some of these videos included recommendations for taking laxatives or extreme fasting (called in some posts as “corpse bride diet”). They also received videos of challenges to lose as much weight as possible within a short period of time and included emaciated girls with protruding bones. Other videos involved shaming those who did not succeed in losing weight. Some of the videos were about eating disorders of which nearly 40% contained text making these disorders appear normal. The *Wall Street Journal* report indicated that at least 800 of the creators that appeared in their bots’ video feeds included weight stats in their profiles, which adds a competitive edge to the videos.
260. Many of the teenagers that *Wall Street Journal* interviewed reported losing control over their TikTok use—one of the hallmarks of addiction: “The app sent them into rabbit holes and they couldn’t stop watching...”
261. The report further notes the rising prevalence of eating disorders in children and adolescents in the recent years as they spend more time on their screens and the association of these disorders with depression and anxiety (Hobbs, Barry, and Koh 2021). The teens that the Journal interviewed believed that TikTok was more harmful for their unhealthy eating behavior than other social media platforms just because of its nonstop stream of videos that made watching effortless.

### 5.3 TikTok, flow state and immersion

262. The immersive platform design which is a prominent feature of image-based apps such as TikTok and Instagram has also likely contributed to development of problematic/addictive use of these media. Indeed, TikTok points out this feature to advertisers as one of the advantages of the app that distinguishes TikTok from other apps. In a 2021 online post, the *TikTok for business* website touted the heightened engagement offered by TikTok as a selling point to advertisers: (<https://web.archive.org/web/20230606040533/www.tiktok.com/business/en-US/blog/tiktok-drives-greater-audience-engagement>). The post refers to an independent study by the *Neuro-Insight* firm that highlights this feature of TikTok's algorithm.

263. The *Neuro-Insight* firm is described as a “a neuromarketing and neuroanalytics company that uses... brain-imaging technology to measure how the brain responds to communications”. The study was conducted on 57 participants aged 18-35 and involved 24 minutes of exposure to TikTok. In this study, TikTok was found to be 44% more approachable (have higher emotional valence) than other social media apps and 15% more engaging (the content being more relevant and memorable). The post notes how these characteristics make TikTok an ideal venue for advertisers:

*“TikTok’s unique engagement signature gives it an edge to be able to deliver ads and branded content in a way and at a moment when consumers are most open to receiving that messaging... TikTok users experience consistently more peaks of engagement during their time with the platform. This further suggests that TikTok users are fully leaned in and immersed on TikTok compared to other platforms... The combination of TikTok’s innovative content preference delivery and short-form sound-on video format appeal to consumers at a deeper emotional level.”*

264. An independent study also examined the neurophysiological effects of exposure to personalized short video clips recommended by TikTok (Su et al. 2021). The authors conducted functional MRI (fMRI) imaging with 30 young Chinese TikTok users (mean age 23.7 years). They also completed the modified version of the Internet Addiction Test in which the term “internet” was replaced with the Chinese name of TikTok (“Douyin”) and a validated scale for measurement of self-control. Twenty-three of the participants scored in the problematic TikTok use range on the screening instrument. Participants were shown two types of videos during imaging: (a) generalized recommended videos for new users that are randomly recommended by the system according to the public preference when TikTok is first downloaded and (b) personalized recommended videos for experienced users downloaded from the participants’ phones after receiving their consent. All participants watched 6 minutes of the general videos and their personalized videos while being imaged.

265. The fMRI showed higher activation of structures in the brain that are part of the “default mode network” and related to increased attention and perception during exposure to personalized videos, whereas structures involved in self-control showed lower activation during viewing targeted videos. In addition, there was increased activity in the brain reward system structures while watching personally recommended videos compared to the general videos. The authors suggested that the differential functioning of these different structures

may help explain the “immersion” experience of TikTok viewers, i.e., a focus on the present perceptions and experiences at the cost of future plans and a shift in attention “from the external/broad attentional focus to internal/narrow attentional focus towards video contents”(Su et al. 2021).

266. The 30 participants of this fMRI study were selected from a pool of 208 young participants who completed the TikTok addiction survey. Nine (4.3%) of these 208 participants scored in a range suggesting severe problems associated with addictive TikTok use.

267. TikTok is a good example of how social media apps are very engaging, likely due to both the personalization of content and the flow state that the users experience (Rach and Peter 2021; Roberts and David 2023). The user is faced with a targeted stream of videos that capture his or her attention for hours. The experience of social media users is often described as a “flow” state or experience, defined as being fully involved or immersed in a pleasurable activity(Csikszentmihalyi 1990). The flow state is associated with focused attention, time distortion and total immersion in the world created by the app. While the experience of the flow state is not by itself harmful, and may be beneficial in many contexts, excessive immersion in social media apps can contribute to the development of social media addiction and restriction in other activities essential for the development of adolescents such as physical activity, face-to-face interactions with peers, sleep, and schoolwork.

#### 5.4 Addictiveness of TikTok

268. Although TikTok was relatively recently introduced, the growing research evidence suggests that it is at least as addictive as the older social media apps. In one study, Smith and colleagues examined addictive use in 173 TikTok users and 313 Facebook users among students from the Caribbean based University of Trinidad and Tobago (Smith and Short 2022). The authors found that TikTok users were somewhat younger than Facebook users (mean age of 23.6 years vs. 26.2 years), spent more time on the app than Facebook users (107 minutes vs. 64 minutes daily), and accessed the app more frequently than Facebook users (3.8 times v. 2.7 times daily). Further statistical analysis based on the Bergen scale scores suggested that 8.7% of TikTok users among these college students could be classified as experiencing TikTok addiction (Smith and Short 2022).

#### 5.5 TikTok algorithm contributes to TikTok addiction

269. Much attention has recently focused on the addictive nature of TikTok algorithms and associated harms to youth. For example, in an online survey with 633 adolescent Chinese TikTok users between the ages of 10 to 19 (mean age 15 years), Qin and colleagues found an association of flow experiences while using TikTok with problematic TikTok use (Qin, Musetti, and Omar 2023). Concentration and time distortion, two important features of the flow state, were significantly associated with problematic TikTok use.

270. In another study of 517 Chinese vocational school students (mean age 19.2 years), Ye and colleagues examined the association of flow states with short video addiction,



learning motivation and the students' sense of "learning well-being" (Ye et al. 2022). Learning wellbeing was defined as a subjective sense of wellbeing in academic life. Example items from the questionnaire assessed how happy the student felt in his/her learning experience and the student's sense of accomplishment.

271. A majority (64%) of these students watched short online videos every day (Ye et al. 2022). The large majority (88.2%) watched at least 1 hour of these videos per day. More than a third (36.8%) reported watching these videos for more than 3 hours per day. These researchers found that short video flow state was significantly and strongly associated with short video addiction. In turn, short video addiction was associated with decreased learning wellbeing through its impact on learning motivation. The authors accordingly recommended that parents, teachers, and students strive to limit the duration of use of short video apps to prevent addictive behavior.

272. The algorithmic targeting of the videos was also found to contribute to the development of TikTok addiction. In an online survey of 388 young Chinese TikTok users (74.5% aged 23 years old or younger), Zhang and colleagues found that both interpersonal attachment to other users of the app and technical features of the app (e.g., targeting of video feeds), contributed to "short video addiction". These investigators noted that:

"On the one hand, short-form video apps enable users to expand interpersonal communication and make new friends, thereby enabling them to develop interpersonal attachment to the apps. On the other hand, the unique technical features and functions of short-form video apps help users easily watch and upload various interesting videos, thereby making them functionally dependent on these apps." (pp. 12-13) (Zhang, Wu, and Liu 2019)

## 5.6 TikTok addiction leads to negative academic and mental health outcomes

273. The impact of excessive and addictive use of TikTok on the academic performance of adolescent users of this app has been another area of concern. In a study in 3,036 Chinese high school students, excessive TikTok use was associated with memory impairment, measured by a task involving remembering and repeating sequences of digits, as well as increased symptoms of depression and anxiety (Sha and Dong 2021).

274. Similar results were obtained in a study of 1,366 students (mean age 15 years) in 3 schools in China. Addictive use of short video platforms including the Chinese version of TikTok (Douyin) and similar apps (Kuaishou, Watermelon Video, Huoshan Video, Tencent Wesee) (Chao et al. 2023) was associated with worse mental health and academic outcomes. More than a third (34.2%) of the users were categorized as addictive users based on their responses to a standardized questionnaire; 51% were moderate users. Only 14.8% of users reported that they did not use any short video apps. Addictive users used the app for longer hours than moderate users on the weekends (4.2 vs. 2.3 hours), but surprisingly, not much longer on weekdays (0.7 vs 0.6 hours). Additionally, compared to moderate users, addictive users were significantly more likely to report academic stress, lower academic performance and victimization by peers. Furthermore, addictive users reported poorer quality of sleep, greater levels of social anxiety, more attention problems, a higher level of depressive and anxiety symptoms, stress and a higher level of feelings of loneliness. The

moderate use group was not different from the non-user group on these outcomes. The authors concluded that their study findings suggest “potentially detrimental effect of addictive short video use among adolescents”, but no such effect for moderate use of these media. However, the relative high prevalence of addictive use in this study, comprising approximately one-third of these Chinese children and adolescents, points to the highly addictive nature of these media and their potential harmful effects.

275. Similar associations were observed in a study of 400 college students in Pakistan (Zahra et al. 2022). Approximately half of these students were between ages 18-24. Higher scores on a TikTok addiction scale were associated with poorer academic performance and higher scores on depression and anxiety scales.
276. The association of excessive TikTok use with sleep deprivation is not limited to adolescents and has been observed in young adults as well. Several features of TikTok, including the endless stream of content, the lack of time stamps or notifications of being caught up with the video feeds and concealing the phone’s clock, are especially conducive to losing track of time and interference with sleep time (Wang and Scherr 2022). In a sample of 1,050 Chinese TikTok users (mean age 29.7 years) who were recruited online, Wang and Scherr examined the association of “automatic TikTok use” with pre-sleep cognitive arousal and increased daytime fatigue (Wang and Scherr 2022). Automatic TikTok use was assessed using items from a standardized scale of automatic behaviors (e.g., engaging in the behavior without thinking and without having to remind oneself). Automatic TikTok use was positively correlated with pre-sleep cognitive arousal ( $r=0.31$ ) and daytime fatigue ( $r=0.21$ ) and negatively correlated with hours of sleep ( $r=-0.08$ ). The effect of automatic TikTok use on daytime sleepiness was mediated by pre-sleep arousal. Furthermore, the association of automatic TikTok use with daytime fatigue was stronger among those participants who scored higher on a scale of sensation seeking trait (the pursuit of new and exciting experiences) and lower on a scale of ability to delay gratification (Wang and Scherr 2022).

## 5.7 TikTok “holidays” reduce mental health harms

277. As noted, Hill identified experimental studies as the most persuasive type of data for establishing a causal link between an exposure and an outcome. Few studies have used experimental designs to specifically examine the association of TikTok use with mental health problems. In one such study, Hunt and colleagues examined whether limiting viewing of short videos about individuals that the participants knew, would reduce social comparison, fear of missing out (FOMO) and symptoms of depression in college students (Hunt et al. 2023). The study found that limiting following to only friends reduced depression. Additionally, it showed that limiting time to 50 minutes per day reduced depression.
278. This study was motivated by previous studies that had shown that people who had more Facebook “friends” whom they did not actually know agreed more strongly with the statement that others led better lives (upward social comparison )(Chou and Edge 2012). In another study, Hunt and colleagues found that the more actual friends people followed, the less lonely they tended to feel (Hunt et al. 2021). The more strangers people followed, however, the more depressed they tended to be and the more they experienced FOMO.

Unlike individuals using more traditional social media apps (e.g., Facebook), where they mostly interact with their circle of friends and acquaintances, TikTok and Instagram users interact mostly or entirely with strangers and their interactions can be one-directional.

279. To test whether the use of impersonal social media apps is associated with social comparison, FOMO or mental health outcomes, Hunt and colleagues randomized 142 undergraduate students at the University of Pennsylvania to one of the following 3 study arms: arm 1 was instructed to limit activity on social media (including TikTok) to one hour per day; arm 2 was instructed to refrain from TikTok, mute (i.e., not receive posts) from anyone whom they did not consider a personal friend on Instagram and limit using of other social media apps to one hour a day; and arm 3 comprised a control group instructed to continue using social media as they usually do (Hunt et al. 2023). App use was monitored weekly by examining screenshots of cell phone screen time reports. Depression was measured by the Beck Depression Inventory (BDI), a validated and commonly used measure of depression. Self-esteem, loneliness, social comparison and FOMO were measured using standardized and validated measures.
280. The two experimental arms reduced time on social media, as expected. Participants in arm 2 showed significant reduction in social comparison at the end of 4 weeks compared to baseline, Participants in the other two arms, however, showed no significant change in social comparison.
281. The study additionally found that the effect of intervention was different among young people with more depressive symptoms than those with less depressive symptoms: participants in experimental groups (arms 1 and 2) who reported more depressive symptoms at baseline showed significantly fewer depressive symptoms after the intervention compared to the control group.
282. The effect of intervention on FOMO was also different between the highly depressed youth and those with less depression. Among those with more depressive symptoms at baseline, Arm 2 participants experienced a significant reduction in FOMO. No such effect on FOMO was found in participants with more depressive symptoms in the two other Arms or in participants with fewer depressive symptoms irrespective of study Arm.
283. The other experimental study that examined the effect of reduced use of TikTok on mental health outcomes is the study by Lambert and colleagues (Lambert et al. 2022). These investigators randomly allocated 154 young adults (mean age=29.6 years) recruited through social media to either stop using these media (including Facebook, Twitter, Instagram, and TikTok) for one week or continue to use them as usual. They measured mental well-being, depression and anxiety using standardized and validated measures. In addition to examining the effect of intervention on the outcomes, they examined the mediating effect of reduction in the time spent on each social media platform as a result of the intervention. The study found significant improvement in wellbeing and reduction in symptoms of depression and anxiety as a result of the intervention overall. The effect of intervention on reduction in depression was mediated by reduction in weekly hours on Instagram and TikTok, whereas the effect of intervention on anxiety was only mediated

through reduction in TikTok use. The effect on well-being was mediated by overall reduction in social media use (Lambert et al. 2022)

## 5.8 TikTok use adversely impacts body image satisfaction

284. The popularity of TikTok among adolescents, especially adolescent girls, and the highly visual nature of this app has heightened concerns about its potential negative impact on body image of users and associated disordered eating behaviors.

285. In one study, Mink and Szymanski examined the effect of TikTok exposure on body image in 778 young female college students of the University of Tennessee (Mink and Szymanski 2022). Participants completed a survey inquiring about the frequency and duration of TikTok use. Body surveillance, body dissatisfaction and upward appearance comparison were assessed using validated questionnaires. The body surveillance measure assessed body consciousness, as well as scrutiny and monitoring of one's body. TikTok use in this study was significantly associated with body dissatisfaction ( $r=0.14$ ) (Mink and Szymanski 2022). Furthermore, the association of TikTok use with body dissatisfaction was fully mediated by upward appearance comparison and body surveillance:

“[T]he more a woman uses TikTok, the more she engages in upward appearance comparison, the more she surveils her body, and thus, the more body dissatisfaction she experiences. These findings suggest that the regular and consistent use of image-based social media applications, like TikTok, which is common among young adult women, may have harmful impacts on women's body image.” (Mink and Szymanski 2022)(p. 212)

286. Given the high prevalence of body image dissatisfaction and the high prevalence of TikTok use the seemingly small correlation coefficient of  $r=0.14$  can translate into a large number of youth. (Doan et al. 2021; Mai 2022; Mink and Szymanski 2022; Borenstein et al. 2009) Concerns about “pro-anorexia” videos led TikTok to remove these videos from the platform. However, new concerns have been raised about the unintended “pro-recovery” videos as well(Logrieco et al. 2021). In a case report on a 14-year-old Italian girl presenting at emergency department with severe anorexia nervosa, who attributed her condition to viewing pro-recovery TikTok videos, Logrieco and colleagues noted:

“During the lockdown, with much more free time on hand, she turned to TikTok for entertainment and came across videos about eating disorders, non-suicidal self-injury (NSSI) and depression, officially aimed at showing the darker sides of these conditions and scare those who romanticized or promoted them. However, she reported that the video makers are often competitive with one another, as they are tempted to prove they are in the worst condition by showing the numbers, calories, and parameters of “being really sick”. We believe that this kind of content, if shown to fragile teenagers, insecure about their body image, may have a paradoxical effect.” (pp. 2-3) (Logrieco et al. 2021)

287. The concerns about the adverse effects of videos that portray recovery from eating disorder was also reflected in a study of 78 adolescents (mean age 14.5 years) recruited from an Italian eating disorder treatment center(Prucoli et al. 2022). Investigators

assessed the frequency of use of TikTok, type of videos viewed on this app, experience of “body-shaming” in these videos, and perceived influence of social media on eating attitudes and self-esteem. Remarkably, 62.8% of these adolescents reported that TikTok was their main social media platform. Videos related to dieting were the most frequently viewed videos. Pro-anorexia videos (e.g., providing users with advice on how to achieve anorexia) and pro-recovery from eating disorder videos were both actively searched by these adolescents and recommended by TikTok. Fifty-nine percent of these adolescents reported that TikTok use was associated with lower self-esteem, 26.9% reported significant change in their daily lives as a result of viewing these TikTok videos. Three participants reported body-shaming while using the medium (Pruccoli et al. 2022). Importantly, the authors noted that 64% of patients in their study found the pro-Ana material without searching for it, and recommend that further investigation be done on the link between the algorithms used by social media and proliferation of disordered eating behaviors.

288. Concerns about the negative impact of social media on body image and eating disorders led the Academy of Eating Disorders to issue an open letter in 2021 calling on social media platforms, including TikTok, to reduce the potential harms of these media (<https://www.newswise.com/articles/urgent-responsibility-to-reduce-harms-posed-by-social-media-on-risk-for-eating-disorders>). The open letter notes that “the preponderance of evidence points to detrimental effects of these platforms on adolescents at risk of, or already suffering from, negative body image, eating concerns and/or depressed mood.” The letter quotes Dr. Abigail Matthews, the clinical director of the Eating Disorders Program at Cincinnati Children’s Hospital who specifically mentions the adverse impact of upward social comparison in her patients who are exposed to these media: “When on these platforms, they are infiltrated with images of their peers who appear to have it ‘all’—perfect bodies and perfect lives.”

## 5.9 Experimental studies show a negative effect of TikTok on body image

289. The impact of TikTok videos on body image of young people has been investigated in experimental studies as well. In one experimental study, Seekis and Kennedy randomized 115 female undergraduate students (mean age 19.4 years) in an Australian university to view 7-minute compilations of short TikTok videos on beauty tips, self-compassion strategies, or travel destinations (Seekis and Kennedy 2023). Following the exposure, the group assigned to beauty videos experienced more appearance shame and anxiety than the other two groups. The beauty group also had the lowest score on the self-compassion scale and on the mood scale. Women in the beauty group also were more likely than women in the group viewing travel ads to engage in upward comparison of their appearance with people portrayed in the videos (Seekis and Kennedy 2023).
290. In another experimental study, Dhadly and colleagues randomized 156 female undergraduate students (mean age 18.4 years) at a Canadian university to view 5 minutes of either (1) body-positive, (2) body-focused or (3) control TikTok content (Dhadly, Kinnear, and Bodell 2023). The participants’ affect and body satisfaction were measured both before and after exposure using standardized scales. Body positive videos were sourced from several accounts that have gained popularity for sending body positive messages on TikTok. For the body-focused arm, videos were sourced from “#bodychecking,” “#bodycheck,” and similar accounts to find videos that predominantly



focused on the shape of the body. For the control arm, videos were selected that were not related to appearance or body shape (e.g., videos of how to make decorative household items or how to wrap gifts). Participants in the body-checking arm experienced both a decrease in body satisfaction and an increase in negative affect; whereas those in the body-positive arm experienced improvement in body satisfaction and reduction in negative affect (Dhadly, Kinnear, and Bodell 2023).

291. A similar design was used by Pryde and Prichard to examine the effect of exposure to TikTok “fitspiration” videos on a group of 120 young (mean age 21.1 years) Australian women (Pryde and Prichard 2022). Fitspiration videos were defined as videos aimed to “inspire” individuals to improve their health and fitness through diet and exercise. Participants were randomized to a group viewing these videos and another group viewing art-related videos. Body dissatisfaction, mood and social comparison were measured using standardized measures. Participants assigned to the fitspiration arm made more appearance comparisons during viewing of the videos, and experienced a significantly larger increase in body dissatisfaction and worse mood compared to the control arm (Pryde and Prichard 2022).
292. Overall, studies reviewed in this section support the causal association of TikTok use with body image dissatisfaction among youth. The algorithmic nature of TikTok may further heighten exposure to these types of videos for youth who already feel insecure about their body shape, hence increasing the harms associated with viewing these videos.

#### 5.10 Excessive and problematic use of Instagram increases the risk of adverse mental health outcomes

293. Several studies have examined the association of excessive use of Instagram as well as Instagram addiction with mental health outcomes. Because Instagram was one of the first “image-based” platforms, much of the past research on the harms associated with excessive or problematic use of this platform has focused on disturbed body image and social comparison. A comprehensive review of 93 such studies examined this literature (Faelens, Hoorelbeke, Cambier, et al. 2021). While the review did not provide any quantitative summary of the results, it noted that of the 10 cross sectional studies that examined the association of the extent of Instagram use with depressive symptoms, 6 (60%) found a small but statistically significant association. The study also noted that

“Several body-related constructs were consistently linked to indicators of Instagram use. More specifically, several studies identified a small positive association between time spent on Instagram and both internalization (of beauty ideals or muscular ideals) and self-objectification across studies.” (p. 6)

294. Another systematic review of 9 of studies that examined young Instagram users (ages 19-35) found a link between Instagram and depressive symptoms (Adeyanju et al. 2021). This review also did not provide a quantitative summary. The authors, however, noted that the reviewed studies suggested that the association was stronger in those who engaged in social comparison, those whose self-esteem was built on validation and approval of others, users who developed social media addiction, females, users who received negative or insufficient feedback, users who had poor self-rated attractiveness and



younger users. The number of strangers that users followed was also one of the moderators in studies reviewed.

295. A more recent meta-analysis of studies examining the association of the intensity of Instagram use with depression and anxiety, as well as the association of problematic Instagram use with these outcomes did report quantitative results (Sepas et al. 2024). Among 19 studies in this meta-analysis that examined the association of excessive Instagram use (measured by time spent on Instagram, the extent of various Instagram activities or using standardized scales) with depressive symptoms and anxiety symptoms, the respective correlations were  $r=0.11$  (95% confidence interval=0.06-0.16) in 19 studies and  $r=0.12$  (0.04-0.21) in 12 studies. Fewer studies examined the association of problematic (addictive) Instagram use with these outcomes, but the associations with depressive and anxiety symptoms were stronger. In four studies that examined the association between problematic Instagram use with depressive symptoms, the correlation was  $r=0.35$  (0.25-0.44); whereas in five studies that examined the association with anxiety symptoms, the correlation was  $r=0.31$  (0.22-0.40). No publication bias was found in this meta-analysis.

#### 5.11 The “dark side” of Snapchat

296. The Snapchat social media platform presents certain distinct features. This platform offers extensive monitoring options in real time, for instance through the use of the “snap map” that allows the continuous and real time monitoring of friends’ live location. In a study of 521 young people (mean age = 19.5), Vanherle and colleagues specifically focused on this feature of Snapchat and its association with depressive symptoms (Vanherle et al. 2023). These authors found that a higher need for popularity was associated with the monitoring of others through Snapchat, which, in turn, was associated with adverse mental health outcomes via fear of missing out. Social surveillance was measured by a questionnaire that specifically asked how often the participants viewed a Snapchat friend’s location without further action, looked to see when others were last online, viewed location of a Snapchat friend and started chatting with this person, viewed a friend’s Snapchat score to see if they were active, and looked to see who has already opened the participant’s story or Snap. While the correlation between Snapchat social surveillance measures and FOMO on the one hand, and depressive symptoms on the other hand, was statistically significant ( $r=0.18$  and  $0.28$ , respectively), the use of Snapchat overall was not associated with depressive symptoms in this study.
297. Another specific feature of Snapchat that may be stressful to some users is the “ephemeral” nature of messages and postings. When users send a “snap,” which can be a video, a picture, or a text-based message, it can only be viewed once and for no more than ten second and stories that the users post will disappear after 24 hours (Dunn and Langlais 2020). These features make the use of this platform for some users stressful as they feel the need to quickly snap interesting texts or pictures to keep up conversations (Dunn and Langlais 2020). A mixed method study of 117 college students’ (mean age 21.7) use of Snapchat focused on different aspects of this platform and their association with adverse mental health outcomes, including depressive and anxiety symptoms (Dunn and Langlais 2020). These authors found that minutes on Snap was associated with depressive and

anxiety symptoms and stress. Chatting and use of maps were specifically related to the level of stress.

298. Lastly, Snapchat offers several features that encourage its users to frequently communicate with each other. These include built-in gamification features that encourage frequent use, such as badges, points, or challenges. Another such feature is the “Snapchat score” which ranks users that use the application most often. Yet another popular feature is the so-called “Snapchat streak”. During a Snapchat streak, users send each other at least one picture every 24 hours. If they do so for more than three days in a row, a flame icon will appear next to the name of the friend. The number next to the flame indicates how many days in a row the users have exchanged images with each other. If users fail to send a back-and-forth message within 24 hours, they will lose the streak and may have to start over again.
299. Maintaining a Snapchat streak can become an important goal for adolescents (van Essen and Van Ouytsel 2023). In focus group interviews conducted by Hristova & Lieberoth, adolescents indicated that engaging in a Snapchat streak offers them the opportunity to renegotiate their relationship with their friends and to participate in a shared project (Hristova and Lieberoth 2021). However, the study also revealed that students viewed breaking a Snapchat streak as a personal rejection. Adolescents often engage in extensive communication to maintain their streaks, such as reminding their partners to snap before the 24-hour deadline in order to rescue a streak, or by asking for an explanation when a Snapchat streak was lost. “Friend emojis” add to the perceptions of social pressure when engaging in Snapchat streaks. Unlike other social media platforms, the frequency of communication on the platform, and thus the strength of the relationships that users have on the platform, is open for others to see, while at the same time the content of the Snapchat messages disappears. This function might lead to distress or jealousy in adolescent friendships and romantic relationships (De Groote and Van Ouytsel 2022; Utz, Muscanell, and Khalid 2015).
300. In a survey of approximately 2500 Belgian adolescents (mean age 13.5), 83% of girls had a “Snapchat streak” compared to 67% of boys (van Essen and Van Ouytsel 2023). Adolescents engaging in Snapchat streaks showed higher levels of problematic smartphone use (measured using a 4-item scale) at a statistically significant level. Within the group with Snapchat streaks, there were significant relationships between the number of people that the adolescent had a streak with and problematic Snapchat use ( $r=0.123$ ), FOMO ( $r=0.146$ ), and low “social media self-control” ( $r=0.106$ ). Similar significant correlations were observed between the duration of the longest streak and problematic Snapchat use ( $r=0.115$ ), FOMO ( $r=0.175$ ), and low “social media self-control” ( $r=0.087$ ). Social media self-control was measured using a scale in which adolescents were presented with the prompt: “I use social media or my smartphone even though...” The scale included statements such as “...I need to postpone other things” and “...it causes me to do other activities less well”. The respondents reported the frequency of each behavior on a 5-point scale (1 = hardly ever, 5 = very often).

## 5.12 YouTube addiction

301. YouTube is the world's most used streaming platform and hosts numerous social media communities (Balcombe and De Leo 2023). The wide reach of YouTube and the possibility to comment on the content makes this platform popular among youth. Teens and young adults tend to spend more time on YouTube than other age groups. According to the Pew Research Center (Vogels, Gelles-Watnick, and Massarat 2022), approximately one in five teenagers in the United States visit or use YouTube almost constantly.
302. An international survey study of over 900 adolescents and young adults (mean age 21 years) found that they spend an average of 6.3 hours per week on YouTube (De Bérail, Guillon, and Bungener 2019). Approximately 18% could be categorized as having a mild level of YouTube addiction based on an adapted version of Internet Addiction Scale modified to assess YouTube addiction. Both "parasocial relationships" (relationship with someone the app user does not actually know but follows on social media) and level of social anxiety, defined as "excessive and persistent fear in social or performance situations that are either avoided or painfully and reluctantly endured," were predictive of addictive YouTube use ( $r=0.37$  and  $r=0.32$ , respectively). The authors noted that while parasocial relationships are not detrimental per se and constitute a way of satisfying the need to belong, which is a fundamental human need, developing parasocial relationships among individuals with social anxiety puts these individuals at risk of developing addictive behaviors (De Bérail, Guillon, and Bungener 2019).
303. The specific reason for using YouTube may also be related to problematic use. A study examining the compulsive use of YouTube among university students found that students who used the platform for entertainment had significantly more compulsive YouTube watching behaviors compared with those using the platform for educational and information purposes (Klobas et al. 2018). These authors distinguished between "compulsive use" of YouTube and "YouTube addiction". Compulsive use was defined by users inability to limit their use, while addictive use was defined by the need to increase interactions for gratification, and experiencing significant negative effects of such use on physical or mental health, relationships, or other aspects of their life in addition to compulsive use. Thus, compulsive use is part of addictive use, but addictive use encompasses a much more extensive involvement with the platform and its adverse outcomes.
304. Much of the past research on the mental health impact of Youtube exposure examined the impact this app along with other short-form video apps (Zhu et al. 2024; Wu et al. 2021; Yu, Zhu, and Li 2024; Zhang, Yang, and Guan 2024). For example, A survey of youth ( $n = 1254$ ) examining the association between social short-form video use (e.g. TikTok, Instagram videos, and YouTube) and mental well-being found that more time spent watching short-form videos was significantly associated with lower positive mood ( $p < 0.001$ ) (Wu et al. 2021). Excessive and problematic use of YouTube appears to be as detrimental to the mental health of youth as other short-form video apps.

### 5.13 Conclusions from research on specific platforms

305. While several studies have focused on specific social media apps, the design and features employed by social media platforms to increase user engagement are very similar. Due to the degree of similarity, there are many commonalities in terms of effects as well, and addictive use, FOMO and repeated, unsolicited targeting by algorithms and notifications are common across the different platforms, justifying a global approach to social media.

## 6 THE PANDEMIC ADVERSELY AFFECTED THE MENTAL HEALTH OF YOUNG PEOPLE

306. While the alarming growing trends in youth depression and anxiety started as early as 2011-2012, the COVID-19 pandemic was associated with further increases in the prevalence of mental health problems in this age group (Tamirisa and Maringanti 2024; Deng et al. 2023). This increase is partly attributable to increased social isolation, parental unemployment and loss, and disrupted routines of these youths which resulted in increased feelings of hopelessness, depression, and generalized anxiety, coupled with increases in drug and alcohol use, suicide attempts, and violent behavior (Tamirisa and Maringanti 2024). The lock-down and social distancing precautions occasioned by the pandemic also contributed to increased use of social media across the board. A natural question that arises is whether the increased use of social media during the pandemic has also contributed to further mental health problems. A growing body of literature specifically addresses these trends in social media use and their potential mental health impacts.

307. A study by Sanzari and colleagues specifically compared two cohorts of US college students (mean age=19 years), one from before the COVID-19 pandemic (2015) and another from after the pandemic (2022). Participants in the 2022 sample reported both more use of social media and greater body image dissatisfaction, more frequent vomiting and laxative use, and more time spent on a greater number of social media accounts, especially image-based platforms such as Snapchat, TikTok, and YouTube. Associations between exposure to weight-loss content on social media with disordered body image and eating behaviors existed in both periods. Most of the 2022 sample attributed spending more time on social media and using a greater number of applications at least partly to the impact of the COVID-19 pandemic.

308. Another study of 765 Italian adolescents using remote education during the COVID-19 pandemic (Marengo et al. 2022) examined the association of use of different platforms with social media addiction in this period. The researchers asked participants to identify the different apps they used and the frequency of use of each, including Facebook, Instagram, Snapchat, YouTube and TikTok. These adolescents used smartphones for long periods each day—roughly half of them used their smartphones for 3 hours or more per day; 11.6% for more than 6 hours (Marengo et al. 2022). The most commonly used apps included YouTube (88.5%), Instagram (75.4%), and TikTok (62%). Most adolescents used multiple social media apps. The groups varied significantly in their scores on the social media addiction scale. Adolescents only using WhatsApp and YouTube showed the lowest scores on social media addiction scale, whereas those who additionally used Instagram and

TikTok showed higher scores. This difference was not simply due to the larger number of apps because adolescents using other combinations of apps did not show this difference. Time spent on the app and the use of TikTok were the strongest predictors of social media addiction.

309. A more recent study examined the effect of limiting the use of social media in college students in 2021. In this study, Thai and colleagues conducted a randomized controlled trial in which 220 participants (17–25 years; 76% female, 23% male, and 1% other) were assigned to either a restricted regime of social media use (1 hr/day) or a control condition (unrestricted access to social media) (Thai et al. 2024). Social media use was monitored daily using screen time tracker apps. Assessments were conducted for 1-week before the trial and during the 3-week trial. Changes in appearance and “weight esteem” (e.g., “I am satisfied with my weight”) were measured using the Body Esteem Scale for Adults and Adolescents. The intervention group experienced significant increases in both appearance ( $d=0.33$ , equivalent  $r=0.16$ ) and weight esteem ( $d=0.27$ , equivalent  $r=0.13$ ) from baseline to post-intervention, whereas the control group experienced no change. No effects of gender were detected.
310. Studies of the association of social media use with mental health outcomes published since the COVID-19 pandemic have been summarized in a number of comprehensive reviews (Draženović, Vukušić Rukavina, and Machala Poplašen 2023; Lee et al. 2022; Marciano et al. 2021). To my knowledge, only two of these reviews provided quantitative summaries (Lee et al. 2022; Marciano et al. 2021). One meta-analysis identified 14 primary studies (Lee et al. 2022). The effect sizes for the association of social media use with both anxiety symptoms (odds ratio [OR]=1.55, 95% confidence interval [CI]=1.30–1.85 equivalent  $r=0.12$ , 95% CI=0.07, 0.28) and depressive symptoms (OR=1.43, 95% CI=1.14–1.80, equivalent  $r=0.130$ , 95% CI=0.04, 0.16) (see Exhibit E for conversion formulas) in the Lee and colleagues’ meta-analysis were in line with pre-COVID studies. The studies, however, were almost exclusively comprised of adults.
311. The meta-analysis by Marciano and colleagues reviewed studies that reported on the link between digital media use and adolescents’ mental health, concluding that while most studies showed a positive association between social media use and negative mental health effects, some types of online communication and interaction had positive aspects. However, the study was not limited to specific mental health outcomes and included general well-being as well as depressive and anxiety symptoms (Marciano et al. 2021). Additionally, this meta-analysis included studies of cell phone use and gaming as well as other digital media use and was not limited to social media use (Marciano et al. 2021). The authors did not conduct separate analyses for social media use and for specific mental health conditions.
312. Another recent meta-analysis examined change in the prevalence of problematic social media use in the time period spanning the pre-COVID and post-COVID era (Casale et al. 2023). The authors did not find any significant changes in the prevalence of social media addiction measured using the Bergen Social Media Addiction Scale, although, the studies were not limited to adolescents and average ages of participants in the primary studies ranged from 13 to 43 years. The authors of the meta-analysis argued that the differences between their findings and some other studies that had recorded an increase in



problematic social media use during the COVID pandemic was attributed to the stage of COVID-19 pandemic. Other studies had mostly used data from the early stages of the pandemic (Fumagalli, Dolmatzian, and Shrum 2021; Gioia et al. 2021), perhaps capturing the “transient negative states (i.e., loneliness) and/or social distance during the lockdown periods”. They argued that these transient problematic social media use symptoms in the early stages of COVID-19 pandemic had “spontaneously remitted” in the subsequent months.” Studies included in the Casale and colleague meta-analyses were from the later stage of pandemic or post-pandemic.

313. Overall, the findings of these studies support the view that social media use and problematic use among youth may have increased at least transiently following the COVID-19 pandemic and that the increase in problematic use of social media may have contributed to the worsened mental health outcomes of children and adolescents during the pandemic. This view is consistent with the multi-causal perspective of child and adolescent mental health problems discussed earlier. The stresses associated with the stay-in orders and social isolation resulting from the COVID-19 pandemic were new exposures and contributing causes along with other contributing causes of youth depression and anxiety. Furthermore, social isolation during the pandemic increased the use of social media apps. As such, the pandemic may have acted as a synergistic factor, increasing the adverse effects of social media use.

## 7 BOTH QUANTITY AND QUALITY OF SOCIAL MEDIA USE IMPACT MENTAL HEALTH

314. While a number of studies have examined the association of social media use with adverse mental health outcomes based on the number of hours of use (Liu et al. 2022), a growing body of research has focused on the quality of social media use irrespective of quantity. In words of Fassi and colleagues,

“The need to move beyond time spent measures of social media use has been widely acknowledged, as these measures are simplistic and fail to distinguish between types of activities or content that can differentially relate to mental health.” (Fassi et al. 2024)

315. Besides problematic or addictive use discussed earlier, social comparison (McComb, Vanman, and Tobin 2023), fear of missing out (FOMO) (Tandon et al. 2021), passive vs. active engagement with the social media (Valkenburg, van Driel, and Beyens 2022) and degree of engagement with social media (Fassi et al. 2024) have been examined.
316. Social comparison has received the most attention among these qualitative factors (McComb, Vanman, and Tobin 2023; Alfasi 2019; de Vries et al. 2018; Fardouly, Pinkus, and Vartanian 2017; Nesi and Prinstein 2015; Vogel et al. 2014). McComb and colleagues conducted a meta-analysis of 48 experimental studies that examined the association of interventions aimed at inducing upward social comparison with mental health outcomes (body image dissatisfaction, subjective well-being, self-esteem, and envy). Social comparison was evoked via exposure to manipulated targets, instructions to scroll through social media feeds, or instructions to use social media as normal. The included studies all



had a control condition, including feeds designed to induce a downward comparison condition. The mean age of participants in the included studies was 22.4 years. The authors reported the outcomes using Hedge's  $g$ . For consistency, I also computed approximate Pearson  $r$  values (for a detailed description of converting Hedges'  $g$  and Cohen's  $d$  to Pearson  $r$ , please see Exhibit E). The overall effect size for exposure to social media feeds was  $g = -0.24$  (equivalent to  $r = 0.12$ ). Adjusting for publication bias reduced this effect to  $g = -0.18$  (equivalent  $r = 0.09$ ). The effect was largest for body image dissatisfaction ( $g = -0.31$ , equivalent  $r = 0.15$ ), followed by self-esteem and mental health outcomes (i.e., depressive and anxiety symptoms) ( $g = -0.21$ , equivalent  $r = 0.10$ ) (McComb, Vanman, and Tobin 2023).

317. The detrimental role of social comparison was also supported in large scale longitudinal studies.
318. In a 1-year follow-up study of 619 US students aged 12-16 years, Nesi and Prinstein found that the level of social comparison and feedback-seeking while using social media was associated with the level of depression at follow-up. The effect was larger among girls and less popular adolescents (Nesi and Prinstein 2015). These findings are consistent with cross-sectional study findings that also indicate that the link between social media use and depressive symptoms is mediated by social comparisons (Steers, Wickham, and Acitelli 2014).
319. Another longitudinal study using daily diaries among 200 adolescents (ages 10-14) also supported the role of upward social comparison as a mediator between social media use and negative affect (Irmer and Schmiedek 2023). Social media use was assessed daily by asking participants how much (1 = "not at all" to 5 = "very much") they had used each of the following social media sites on that day: Instagram, YouTube, and TikTok. Negative affect was assessed daily using 4 questions about feeling unhappy, sad, miserable, or afraid. Upward social comparison was also assessed daily using a standardized questionnaire. The study assessed other outcomes as well, including positive affect and negative and positive self-worth. In between-person analyses the authors found that the extent of social media use was a significant predictor of upward social comparison, and that the effect of social media use was fully mediated by social comparison. They concluded that the findings indicated that social media use was indirectly linked to reduced subjective wellbeing by strengthening users' impression of "others being happier, more popular, and prettier or having cooler stuff or a better life." In the within-person model, the effects were smaller and did not reach a statistically significant level. The discrepancy of between- and within-person results suggests that certain adolescents are more prone to experiencing both upward social comparison and negative affect as a result of excessive use of social media (hence the significant between-person effects). After taking these between-person differences into account, the effect of day-to-day variations in social media use on social comparison and negative affect are minimized (hence the non-significant within individual effects).
320. In a more recent meta-analysis, Fassi and colleagues conducted a review of 143 primary studies that examined the association of internalizing symptoms in adolescents with either time spent on social media or user engagement with social media (Fassi et al. 2024). Engagement was defined by type of social media activities (e.g., selfie posting) and

user perception (importance of social media use to daily life). Both these indicators of social media use were significantly associated with internalizing symptoms (time spent  $r=0.08$ ; 95% CI, 0.01, 0.15; user engagement  $r=0.12$ ; 95% CI, 0.09, 0.15). The authors found no evidence of publication bias.

321. Overall, research supports the view that both a greater degree of exposure as quantified by the number of hours of use and the quality of engagement with social media (e.g., addictive use, engaging in social comparison) contribute to adverse mental health effects of social media in youth (Liu et al. 2022). The role of these factors in development of mental health problems likely varies by type of mental health problems. For example, social comparison of body shape may be more important in development of body dissatisfaction, whereas, long hours of social media use may be a more important factor in development of sleep problems. Furthermore, individual adolescents may have different vulnerabilities to different types of exposure (Adeyanju et al. 2021).

## 8 RESEARCH CONTESTING A CAUSAL LINK BETWEEN SOCIAL MEDIA AND MENTAL HEALTH

322. While the preponderance of research referred to in earlier pages supports a link between maladaptive patterns of social media use (e.g., excessive use, addictive use, negative social comparison) and adverse mental health outcomes, some published studies either do not support this association or suggest that the magnitude of this association is very small and not a serious health concern. In previous sections I discussed criticisms regarding the magnitude of the effect size. Here I will discuss some highly cited studies that raised doubt about the causal association of excessive or maladaptive social media use with adverse mental health outcomes.

323. At the outset I should note that in every field of science contradictory findings are to be expected. When hundreds of studies examine association of a risk factor with a health outcome, some of these studies produce outlier findings just by chance. While examining the reasons for these discordant findings carefully is important, the conclusion should be based on preponderance of evidence and replicated, consistent and supportive findings.

### 8.1 Orben and Przybylski's reanalysis of survey data

324. One of the most commonly referenced studies that raises doubt about the social media and mental health link is a study by Orben and Przybylski that re-examined 3 large population surveys—the Monitoring the Future (MTF) and the Youth Risk and Behavior Surveys (YRBS) from the US and Millennium Cohort Study (MCS) from UK. The authors used a novel method called Specification Curve Analysis (SCA) (Orben and Przybylski 2019) to examine the association of social media use with outcomes in these surveys. As these authors describe the method,

“...SCA is a tool for mapping the sum of theory-driven analytical decisions that could justifiably have been taken when analysing quantitative data. Researchers demarcate every possible analytical pathway and then calculate the results of each. Rather than reporting a handful of analyses in their paper, they report all results of all theoretically defensible analyses.” (p. 174)

325. This means that they computed a large number of regression models with different covariates and tested all of them rather than pre-specifying a model. This strategy reduces the risk of cherry-picking and selecting a specific model based on the results of the analysis. Additionally, they tested the association of other potential risk factors (e.g., reduced sleep, not eating breakfast, illicit drug use) with the same mental health outcomes and compared their effects with the effect of social media use. They also examined some less plausible risk factors for adverse mental health outcomes (e.g., eating potatoes).
326. Because each survey included many variables, the analyses included thousands of specifications (i.e., regression models), each with a different combination of covariates. The median regression coefficient from these regression models was chosen to represent the effect of each risk factor.
327. They found generally small effects for the association of “technology use” (including social media use) with “adolescent well-being”. Further, the definition of technology use and how it was measured varied across the 3 surveys. Similarly, the definition of “well-being” and how it was operationalized varied across the surveys.
328. There are several limitations in the analysis of Orben and Przykylski that need to be considered. Some limitations pertain to the relevance of the findings of the study for my report and the questions I focus on. Other limitations pertain to the methodology and analytic choices that Orben and colleagues made.
329. The topic of my report is the association of maladaptive use of social media (excessive use, addictive use, social comparison) with mental health outcomes. Orben and colleagues, in contrast, assessed association of technology use broadly (including TV use and mobile phones) with outcomes. Only one of the surveys (MCS) looks specifically at hours of social media use as an exposure.
330. My report also focuses on specific mental health outcomes: depressive/anxiety symptoms or disorders, suicidal ideations/attempts, body image dissatisfaction/eating disorders and sleep problems. The Orben and Przykylski report has a broader focus and assesses association of technology use with “well-being,” defined broadly. Only the YRBS survey measure of “well being” was made up of depressive symptoms and suicidal ideations, and there are some items that overlap with the specific mental health outcomes in the two other surveys (for example Strengths and Difficulties Questionnaire Emotional Symptoms subscale, but the median effects reported are for all well-being measures combined or aggregated over all items). The MTF and MCS survey ratings of well-being were comprised of a mixture of depressive symptoms and other questions such as satisfaction with life, feelings about family, self-esteem, etc. However, separate analyses for the association of social media use with depressive symptoms in YRBS are not reported. Separate results are reported for “electronic device use only” and “TV use only” but not social media.
331. Overall, the results of Orben and Przykylski’s study are not very relevant to my report as they do not assess the association of extent or type of social media use with

individual harms, including depression, anxiety, suicidal ideations/attempts, sleep problems or body image disorder.

332. Twenge and colleagues have also commented on Orben and Przykylski's report (Twenge et al. 2020). They point to six analytic decisions that Orben and colleagues made that may have influenced their findings and caused discrepancies with other research, and in a later publication, Twenge and colleagues repeated Orben and Przykylski's analyses addressing the limitations that they had noted in their 2019 paper (Twenge et al. 2022). Specifically, they 1) examined specific digital media activities (e.g., social media) separately rather than lumping all "screen time" including TV, together; 2) examined boys and girls separately, rather than examining them together; 3) excluded potential mediators from the list of controls; and 4) examined scales rather than items. With these changes they found several much larger relationships than previously reported, including a consistent and substantial association between mental health and social media use (median betas from -0.11 to -0.24) for girls. In contrast to Orben and Przykylski's findings, they found that these associations were stronger than links between mental health and binge drinking, sexual assault, obesity, and hard drug use.
333. The new set of analyses by Twenge and colleagues are much more in line with the questions addressed in my report and support the link between social media use and adverse mental health outcomes.

## 8.2 Ferguson's meta-analysis of experimental studies

334. A recent meta-analysis by Christopher Ferguson has received attention as it is among the few meta-analyses of experimental studies (Ferguson 2024). As a safeguard against making findings based on correlational data and small effects, the meta-analysis considered experiments only and used a criterion of the smallest effect size of  $d > 0.21$  ( $r > 0.10$ ) as an indicator of meaningful effects, "to reduce the potential for overinterpretation of noise-related results". Studies were selected that used a validated standard outcome measure and the intervention had to manipulate time of exposure to social media. The author identified 27 experimental studies. The estimated effect size from these studies was  $d = 0.088$ , below the  $r = 0.10$  threshold. This is indeed a small effect size. Based on this finding, Ferguson concluded that mean effect sizes are no different from zero, which he concludes undermines causal claims that reductions in social media time would improve adolescent mental health.
335. However, there are significant limitations in Ferguson's study. The mental health outcomes measured in the large majority of the included studies were not depressive or anxiety symptoms, or if these outcomes were measured they were aggregated with other outcomes, including loneliness, quality of life, and general wellbeing. Curiously, Ferguson only analyzed one effect size per study, even for studies with multiple measures. Presumably, this outcome measure is an average of outcomes for different measures (although the author does not provide any information as to whether and how the outcome measures were combined). These limitations were noted in a post by David Stein, Zach Rausch and Jon Haidt regarding this meta-analysis (<https://shoresofacademia.substack.com/p/fatally-flawed-social-media-experiments>; <https://www.afterbabel.com/p/fundamental-flaws-part-2>).

336. Rausch and Haidt raise a number of problems in Ferguson's meta-analysis in addition to lack of transparency in calculating effect sizes and combining effect sizes of different measures. The additional problems include errors in computing effect sizes, errors in sample size computation, including failed experiments that should not have been included and excluding studies that should have been included. Curiously, all the errors are in the same direction, biasing the results of the meta-analysis towards null (i.e., showing that there is no experimental link between social media use and measures of well-being).
337. More recently, Thrul and colleagues criticized Ferguson for combining long and short term trials and not investigating the potential moderating effects of length of social media reduction or abstinence interventions (Thrul et al. 2025). These authors reanalyzed Ferguson's data by dividing the primary studies into longer term (1 week or longer) and short term (less than 1 week) trials. When they repeated the analyses in these two groups of trials, they found that interventions of less than 1 week resulted in significantly worse mental health outcomes ( $d=-0.168$ ,  $SE=0.058$ ,  $p=0.004$ ), while interventions of 1 week or longer resulted in significant improvements ( $d=0.169$ ,  $SE=0.065$ ,  $p=0.01$ ). Shorter trials likely capture withdrawal effects of stopping social media use—a phenomenon observed in other behavioral addictions as well (Wray and Dickerson 1981). The beneficial effects of stopping or reducing social media use become apparent only when the withdrawal effects are reduced. Based on these results, Thrul and colleagues suggested that the optimal period of reduced use or abstinence from social media in randomized trial should be about 3 weeks (Thrul et al. 2025).
338. Differences in the effect of experimental social media holidays on different outcomes were more recently highlighted in another meta-analysis by Ramadhan and colleagues (Ramadhan et al. 2024). These authors identified 10 studies (3 of them overlapping with studies reviewed by Ferguson) that examined the effect of experimental studies of social media restriction (what they called "social media detox"). They found a significant reduction in depressive symptoms as a result of social media restrictions ( $d= -0.29$ , 95% CI= $-0.51, -0.07$ ;  $p=0.01$ ; equivalent  $r=-0.14$ ), whereas the effect on "mental well-being" was negligible and non-significant ( $d=0.04$ , 95% CI= $-0.54, 0.62$ ,  $p=0.90$ ). As such, aggregating measures of depressive symptoms with measures of general well-being, which is what Ferguson did, would significantly bias the results of the experimental studies.
339. In summary, the results of Ferguson's meta-analysis do not provide any reliable evidence against a causal link between social media use and adverse mental health outcomes.

## 9 SUMMARY OF RESEARCH

340. In the previous sections of this report, I reviewed research on the association between use of social media and mental health problems. I also reviewed data on the prevalence of problematic/addictive use of social media. Despite variations across these studies, there was remarkable consistency in the findings. Below I summarize the salient themes of this research:

- a) The results of cross-sectional and longitudinal studies are remarkably consistent in showing a causal relationship between excessive and problematic social media use or maladaptive patterns of social media use (e.g., engaging in social comparison) and mental health problems. Of course, not all studies find a statistically significant relationship, but the majority do, as summarized in several meta-analyses. The magnitude of this relationship varies across different studies but is generally in the range of  $r=0.11-0.13$ . To put these numbers in context, Gignac and Szodorai's found that out of 199 meta-analyses in psychology journals and spanning the area of differential psychology, 25%-30% produced effect sizes of  $r=0.11$  to  $r=0.13$  or smaller (Gignac and Szodorai 2016). Given the universal use of social media among adolescents, this correlation translates into tens of thousands of children and adolescents experiencing mental health problems as a result of this exposure.
- b) The consistency across meta-analyses and within meta-analyses is remarkable because these meta-analyses were based on different populations and were from different countries. Furthermore, the primary studies used different methods to adjust the results for factors that could potentially confound the association of social media use with mental health problems. It is also notable that few of the meta-analyses detected publication bias, suggesting that few studies were unpublished due to lack of significant findings, and that the meta-analyses portray a representative picture of the associations in the population.
- c) In studies examining the association between the quantity of exposure to social media (e.g., number of hours) and mental health problems, a dose-dependent relationship exists (Riehm et al. 2019; Sampasa-Kanyinga, Hamilton, and Chaput 2018; Lin et al. 2016). Along with the studies referenced above, a meta-analysis that specifically examined the dose-response relationship of number of hours of social media use with mental health problems estimated that the risk of depressive symptoms increases by about 13% on average for each 1 hour increase in daily social media use (Liu et al. 2022).
- d) While it is difficult and ethically problematic to conduct experiments in which participants are randomized to excessive use of social media, several experimental studies have examined the effect of social media "holidays" or temporary restrictions on the use of social media. These studies have generally found positive effects on several mental health outcomes as a result of these holidays or restrictions. Other studies have examined the effect experimentally induced social comparison (McComb, Vanman, and Tobin 2023). These studies have found adverse mental health outcomes associated with upward social comparison.
- e) The association between excessive social media use and body image dissatisfaction is somewhat larger than the association with depressive symptoms. A correlation of 0.21 (95% CI=0.15-0.27) was found in a meta-analysis that I conducted for this report based on 21 primary studies of adolescent samples drawn from a larger meta-analysis of 63 studies across all ages (Saiphoo and Vahedi 2019). The population effect on body image may be more prominent with highly visual social media apps that are more commonly used by youth, and are more likely to induce upward social comparison.



- f) A sizeable proportion of adolescents who use social media develop signs and symptoms of social media addiction (estimates range from 4.5% to 12.2%). Given that almost all adolescents are currently social media users, these numbers translate to thousands of adolescents and young adults.
- g) Several aspects of social media platforms contribute to addictive use including “incentive salience” (highly pleasurable stimuli such as receiving “likes” or positive comments on posts), ability to switch seamlessly between different features on increasingly feature-rich platforms, the “immersive” nature of these media, and the “algorithmic” nature of some of the social media apps (Nesi et al. 2021). These features encourage staying on the site for hours at the cost of giving up other activities such as in-person social interactions and sleep.
- h) The introduction of highly visual social media such as TikTok and Instagram, discussed at length in my report, presents all of the concerns of “older” social media, but at a heightened level. These Apps (Snap, YouTube, Facebook, Instagram, and TikTok) appear to have increased the level of user engagement attained, in part due to algorithms that create highly immersive experiences for users.
- i) In addition to the amount of exposure, the type of engagement with social media appears to be important for development of adverse mental health outcomes. Upward comparisons, in which the person compares herself or himself unfavorably with peers whose pictures, “stories”, or videos are posted on social media apps is especially conducive to mental health problems in correlational studies as well as experimental studies. Problematic use that is associated with addiction symptoms (such as withdrawal and giving up other activities) is also conducive to other mental health and social harms (e.g., depression; academic problems). Indeed, problematic use, social comparison, flow state, and disruption of other activities (such as sleep) may be the main mechanisms of the harmful effects of excessive social media use.

## 10 THE PLAUSIBILITY OF A CAUSAL ASSOCIATION

341. I now examine the findings of the existing literature in light of Hill’s guidelines, remembering that, in the words of Hill, these guidelines are meant to “...help us to make up our minds on the fundamental question—is there any other way of explaining the set of facts before us, is there any other answer equally, or more likely than cause and effect?”(Hill 1965).

342. **Strength of associations** is Hill’s first criterion. The associations found between excessive social media use and mental health problems are relatively modest but significant, mainly remaining in the range of  $r < .3$ . As Hill himself noted, many correlations of known causal relationships are in this range, including the correlation of air pollution and lung cancer ( $r = 0.03$ ) (Hamra et al. 2014). With the advent of big data and sophisticated analytic methods it is now possible to assess smaller effects that are statistically meaningful. One of the tools commonly used by statisticians to assess whether the findings are beyond what would find by chance is statistical significance testing (Fedak et al. 2015).

For example, a statistically significant finding at  $p < 0.05$  tells us that the chances that the findings are the result of random variations is less than 1 in 20. Confidence intervals similarly identify the range of likely values. For example, a 95% confidence interval suggests that if repeated 100 times, 95 times the results fall in the identified interval. Indeed, the large majority of correlations examined in this report were statistically significant, as indicated by the confidence intervals for correlation coefficients that did not cover 0. Limitations in relying on statistical testing as the sole measure of an association should be noted because p values are dependent on the sample size (i.e., a small effect in a large study may be significant whereas a large effect in a small study would be statistically non-significant). Nevertheless, if interpreted appropriately and in conjunction with the effect size, statistical significance testing can provide guidance.

343. **Consistency** of findings was another of Hill's causal guidelines. Results of the studies that I examined are remarkably consistent, meeting this criterion. The results were consistent across studies conducted in different settings and countries, with different populations and using different measures of exposure and outcome. For example, there was remarkable consistency among 11 meta-analyses of the association of social media use with depressive symptoms and suicidal ideations/behaviors that I identified (Cunningham, Hudson, and Harkness 2021; Huang 2017, 2022; Ivie et al. 2020; Liu et al. 2022; Yoon et al. 2019; Shin et al. 2022; Vahedi and Zannella 2021; Marino et al. 2018; McCrae, Gettings, and Purssell 2017; Baker and Algorta 2016; Lee et al. 2022). Meta-analyses of the association of social media use with body image dissatisfaction were also remarkably consistent (Blanchard et al. 2023; de Valle et al. 2021; Huang, Peng, and Ahn 2021; Mingoia et al. 2017; Saiphoo and Vahedi 2019). While some of the meta-analyses identified heterogeneity in effects, suggesting that the magnitude of the associations varied among studies, the primary studies in these meta-analyses were consistent in finding a significant association between social media use and mental health problems in the same direction—more use of social media was associated with greater likelihood of mental health problems. Also notably, studies using different designs (cross-sectional, longitudinal, experimental) produced consistent results, all pointing to the same association.
344. **Specificity** of the effects is another of Hill's guidelines. Considerable overlap among mental health outcomes (i.e., depression, internalizing problems, suicidal ideations, body image dissatisfaction, social media addiction) and ubiquity of social media across countries and population groups makes identifying specific relationships difficult. Nevertheless, some findings point to specificity of the relationships. For example, the finding that use of more “visual” media has a stronger relationship with body image dissatisfaction (Engeln et al. 2020), and identifying age windows when exposure to social media may be more harmful, especially for young girls (Orben et al. 2022), point to the specificity of the effect. The association also appears to be stronger for internalizing problems and smaller or non-existent for externalizing behaviors (rule breaking and use of substances) (Riehm et al. 2019). Moreover, as Hill recognized “diseases may have more than one cause” and “[o]ne-to-one relationships are not frequent.” (Hill 1965). As I've discussed in this report, due to the multicausal nature of mental health problems, the presence of more than a single cause of these effects does not negate the causal influence of excessive or problematic use of social media as a substantial component cause.

345. **Dose-response** relationship between cause and effect has been investigated in several longitudinal studies, including a study by my team in which a larger number of hours spent on social media was associated with more severe internalizing symptoms a year later (Riehm et al. 2019), even after adjusting for pre-existing mental health problems. This study as well as other studies in the meta-analysis by Liu and colleagues (Liu et al. 2022) also supported a dose-response relationship or the “biological gradient” guideline in the set of Hill’s causal guidelines.
346. **Temporality** of the associations between social media exposure and mental health outcomes has been a focus of a number of longitudinal studies (Mundy et al. 2021; Boers et al. 2019; Riehm et al. 2019), including a study by my team discussed earlier (Riehm et al. 2019). An important consideration in establishing a causal link is temporal order of cause and effect. This is generally considered a limitation of cross-sectional research. However, the majority of longitudinal studies support a temporal association.
347. **Plausibility and coherence** are arguably the most closely related guidelines among Hills guidelines. The rise in child and adolescent depression and the coinciding association of social media use with mental health outcomes support plausibility and coherence of a causal link between these phenomena. The rise in prevalence of depression and depressive symptoms in children and adolescents in the US and other industrialized countries in the past decade is well documented. The parallels between these time trends and the trends in spread of social media use are highly suggestive of a causal link. Most studies examining the trend in adolescent depression note the introduction and widespread use of social media as a substantial contributing factor for this trend (Askari et al. 2023). Few other risk factors show a similar increasing trend over the past decade. The growing body of research in this area further supports the plausibility and the coherence of this association with existing knowledge about adolescent development. When I searched the PubMed for the search terms of (social media) AND (mental health) I was able to identify over 7,200 publications, more than half of which were published in years 2021-2025. This suggests that an association between social media use and mental health is both plausible and coherent with the current scientific understanding.
348. Several features of social media exposure are consistently related to the adverse mental health outcomes. Importantly, a number of experimental studies have shown that exposure to social media is conducive to upward social comparison and negative affect in volunteers (de Vries et al. 2018; Alfasi 2019; Lambert et al. 2022; Yuen et al. 2019; Ozimek and Bierhoff 2020) (McComb, Vanman, and Tobin 2023; Weinstein 2017). Other experimental studies have examined the effect of social comparison of body image on body image dissatisfaction (Engeln et al. 2020; Sherlock and Wagstaff 2019). Based on this body of evidence, it is quite plausible that prolonged exposure to social media can lead to more enduring negative affect and body image dissatisfaction.
349. A number of studies also find that excessive social media replaces other normative behaviors and basic needs in youth, such as needs for physical activity, in-person social interactions, and sleep (e.g., Davison et al. 2022; Viner et al. 2019; Sampasa-Kanyinga, Hamilton, and Chaput 2018; Yu, Zhu, and Li 2024). As such, it is plausible that factors that interfere with these normative behaviors—such as excessive social media use—would lead to lower well-being and increased distress.

350. **Experimental evidence** was given the highest weight by Hill among his guidelines. In his words, “...here the strongest support for the causation hypothesis may be revealed” (Hill 1965). While it is probably not ethical or even feasible to randomize participants to excessive use of social media in an experiment, several studies have examined the effect of short social media holidays and restrictions (Ramadhan et al. 2024; Vanman, Baker, and Tobin 2018; Allcott et al. 2020; Tromholt 2016; Hunt et al. 2018). Almost all found beneficial mental health effects. Other experimental studies have exposed volunteer participants to social media feeds eliciting negative affect, upward social comparison or body image dissatisfaction (de Vries et al. 2018; Alfasi 2019; Lambert et al. 2022; Yuen et al. 2019; Ozimek and Bierhoff 2020; McComb, Vanman, and Tobin 2023; Weinstein 2017; Engeln et al. 2020; Sherlock and Wagstaff 2019). Overall, these results provide further evidence supporting a causal link between social media use and adverse mental health outcomes.

351. **Analogy** between social media exposure and exposure to other media with similar “addictive” qualities, such as Internet gaming, may provide an appropriate analogy to further support a causal link (Burleigh et al. 2020; Kuss and Griffiths 2012; Zajac et al. 2017; Oelker et al. 2024). Social media addiction and internet gaming addiction share many features, both are associated with loss of control over use and continued use despite negative impact, both especially affect children and adolescents, and both are associated with other psychological harms (Ostinelli et al. 2021; Paulus et al. 2018). Internet gaming disorder was added to the DSM-5-TR as “Conditions for Future Study” (American Psychiatric Association 2022) and included in the 11<sup>th</sup> edition of the International Classification of Diseases as a disorder that is...

“...characterised by a pattern of persistent or recurrent gaming behaviour (‘digital gaming’ or ‘video-gaming’), which may be online (i.e., over the internet) or offline, manifested by: 1. impaired control over gaming (e.g., onset, frequency, intensity, duration, termination, context); 2. increasing priority given to gaming to the extent that gaming takes precedence over other life interests and daily activities; and 3. continuation or escalation of gaming despite the occurrence of negative consequences.” (World Health Organization 2022)

352. Overall, the evidence linking the use of social media with social media addiction, depression (including self-harm and suicidality) and body image disturbance conforms to Hill’s guidelines for a causal relationship.

## 11 CONCLUSION

353. In conclusion, based on my education, training, and experience, review of the totality of the existing evidence, analysis and weighing of the data in the context of Bradford Hill considerations, it is my professional opinion, stated to a reasonable degree of medical and scientific certainty, that problematic use of social media can cause or contribute to depressive symptoms, body image disturbance and other adverse mental health outcomes in adolescents and young people. Studies also support my opinion that multiple features built into social media platforms are conducive to their excessive and

problematic use and that these features increase the risk of addictive use of the app and other adverse mental health outcomes.

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- Zhao, Jin, Ting Jia, Xiuming Wang, Yiming Xiao, and Xingqu Wu. 2022. 'Risk factors associated with social media addiction: An exploratory study', *Frontiers in Psychology*, 13: 837766.
- Zhu, Chengwei, Yiru Jiang, Hanning Lei, Haitao Wang, and Cai Zhang. 2024. 'The relationship between short-form video use and depression among Chinese adolescents: Examining the mediating roles of need gratification and short-form video addiction', *Heliyon*, 10.

# EXHIBIT A



Billing Rate and History of Testimony for Dr. Ramin Mojtabai

Hourly rate for Ramin Mojtabai: \$500 per hour for all services, with the exception of deposition and trial testimony, which is billed at \$1000 per hour.

Deposition and Trial Testimony in the last five (4) years: None

# **EXHIBIT B**

April 2025

## **CURRICULUM VITA**

Ramin Mojtabai

Part I

### **CONTACT INFORMATION**

E-mail: rmojtabai@tulane.edu

Work address: 1440 Canal St., Suite 1000, New Orleans, LA 70112

Work phone: (504) 988-5246

Home address: 115 Kellywood CT, Belle Chasse, LA 70037

Cell phone: (917) 596-5164

### **EDUCATION, TRAINING and CERTIFICATION**

**1988:** M.D., Tehran University of Medical Sciences, Iran

**1994:** M.A. in Clinical Psychology, University of Tulsa, OK

**1996:** Ph.D., in Clinical Psychology, University of Tulsa, OK

**1996-1999:** NIMH Postdoctoral Fellow in Schizophrenia Research at the Department of Psychiatry, College of Physicians and Surgeons, Columbia University, New York

**2000:** Licensure in Psychology, New York State Education Dept., Office of Professions (inactive)

**2002:** M.P.H., Mailman School of Public Health, Columbia University, NY

**2003:** Educational Commission for Foreign Medical Graduates (ECFMG) certification

**2007:** Licensure in Medicine and Surgery, New York State Education Dept., Office of Professions (inactive)

**2008:** Licensure in Medicine and Surgery, Maryland Board of Physicians (active)

**2009:** Board Certification in Psychiatry, American Board of Psychiatry and Neurology (active)

**2024:** Licensure in Medicine, Louisiana State Board of Medical Examiners (active)

### **PROFESSIONAL EXPERIENCE**

**2024-Present:** Professor (tenured) and Vice Chair of Research; Venancio Antonio Wander Garcia IV, MD Chair in Psychiatry, Department of Psychiatry and Behavioral Sciences, Tulane Medical School

**2014-2024:** Professor (tenured), Department of Mental Health, Bloomberg School of Public Health with joint appointment in the Department of Psychiatry and Behavioral Sciences, School of Medicine, Johns Hopkins University, Baltimore, MD.

**2013-present:** Director of the Certificate Program in Mental Health Policy, Economics and Services, Bloomberg School of Public Health

**2008-present:** Attending Physician, Community Psychiatry Program, Department of Psychiatry, Johns Hopkins Hospital, Baltimore, MD.

**2008-2014:** Associate Professor, Department of Mental Health, Bloomberg School of Public Health with joint appointment in the Department of Psychiatry and Behavioral Sciences, School of Medicine, Johns Hopkins University, Baltimore, MD.

**2007-2008:** Senior Resident in Research, Department of Psychiatry, Beth Israel Medical Center/Albert Einstein College of Medicine, New York, NY.

**2004-2007:** Resident in Psychiatry, Department of Psychiatry, Beth Israel Medical Center/Albert Einstein College of Medicine, New York, NY.

**1999-2004:** Assistant Professor of Clinical Psychiatry, Department of Psychiatry, College of Physicians and Surgeons, Columbia University and Research Scientist, New York State Psychiatric Institute, New York, NY.

**1995-1996:** Intern in Clinical Psychology at the Department of Psychiatry, George Washington University Medical Center, Washington, DC.

**1993-1995:** Psychology Extern at the Counseling Center of the University of Tulsa, Family and Children Services, and Developmental Pediatrics and Center for Family Psychology, Tulsa, OK.

**1992-1995:** Teaching and Research Assistant, Department of Psychology, University of Tulsa, Tulsa, OK.

**1988-1991:** Resident in Psychiatry, Roozbeh Hospital, Tehran University of Medical Sciences, Tehran, Iran.

**1987-1988:** General Medical Intern at the University Hospitals of the Tehran University of Medical Sciences, Tehran, Iran.

## **PROFESSIONAL ACTIVITIES**

### **Society Memberships**

Fellow, American Psychiatric Association

Member, Louisiana Psychiatric Medical Association

### **Consultantship**

2023: Consultant on the general anxiety survey report; MindMed, Inc.

2022: Consultant on the survey of behavior health help-seeking; SURGO Ventures, Inc.

2022: Consultant on the UAE's Mental Health Strategy, Price Waterhouse Coopers (Dubai Branch)

2021: Consultant on the Social Justice Platform Health and Social Equity Project, MITRE Inc.

2017: Member, Technical Advisory Group on SAMHSA Block Grant Formulas, Rand Corporation

2015-2023: Affiliate faculty member, Iranian National Center for Addiction Studies. Tehran University of Medical Sciences

1996-2002: Staff member for the National Collaborative Study of Early Psychosis and Suicide (PI: Dr. Richard J. Wyatt).

1996-2008: Consultant on the Suffolk County Mental Health Project (PI: Dr. Evelyn Bromet), SUNY at Stony Brook, NY.

### **Conference Organizer**

2012: "The Future of Behavioral Health in America: Opportunities and Challenges." A symposium sponsored by the Center for Mental Health Initiatives, Department of Mental Health, JHSPH. Organized in collaboration with Eaton, W.W., Leaf, P., Baltimore, MD, September 18, 2012.

2009: Department of Mental Research Seminar Series (first quarter)

2006: "Acute Brief Psychoses: Nosology and Boundaries"; symposium co-chaired with Susser, E. at the 159<sup>th</sup> Annual Meeting of the American Psychiatric Association, Toronto, Canada, May 2006

### **EDITORIAL ACTIVITIES**

#### **Writing Group Membership**

2017-present: Core member of the writing group for the APA Practice Guidelines, American Psychiatric Association

#### **Editorial Board Membership**

2011-present: *Clinical Medicine Insights: Case Reports* (Sage)

2014-2023: *Psychiatric Services* (American Psychiatric Association)

2006-present: *Iranian Journal of Psychiatry and Behavioral Sciences* (Mazandaran University of Medical Sciences; Sari, Iran)

#### **Grant Review**

2020-2024: Standing member, Community Influences on Health Behavior Study Section (CIHB), Center for Scientific Review, NIH

2023: Ad hoc reviewer: Special Emphasis Panel/Scientific Review Group 2023/05 ZRG1 SCIL E (90)

2022: Peer reviewer for the Frontier Research Proposals of the European Research Council (ERC), European Commission

2020-present: Standing member, Community Influences on Health Behavior Study Section (CIHB), Center for Scientific Review, NIH

2019: Ad hoc reviewer, HEAL Initiative: Effectiveness Trials to Optimize, Implement, Scale, and Sustain the Collaborative Care Model for Individuals with Opioid Use Disorders and Mental Health Conditions (U01); RFA-MH-19-525, NIH

2019: Ad hoc reviewer, Community Influences on Health Behavior Study Section (CIHB; Special Emphasis Panel/Scientific Review Group 2019/05), Healthcare Delivery and Methodologies IRG, Center for Scientific Review, NIH

2018: Ad hoc reviewer, Community Influences on Health Behavior Study Section (CIHB; Special Emphasis Panel/Scientific Review Group 2018/10), Healthcare Delivery and Methodologies IRG, Center for Scientific Review, NIH

2013: Ad hoc reviewer, Special Emphasis Panel/Scientific Review Group 2013/10 ZMH1 ERB-K (03)

2012: Ad hoc reviewer, Special Emphasis Panel/Scientific Review Group 2013/05 ZMH1 ERB-D (03)

2012: Ad hoc reviewer, Special Emphasis Panel/Scientific Review Group 2013/01 ZRG1 PSE-B

2009: Ad hoc reviewer, NIMH RFA-MH-09-140 review committee, "Collaborative Study of Suicidality and Mental Health in the U.S. Army"

2013: Reviewer, Dutch Organisation for Health Research and Development (ZonMw), September

2002-2010: Reviewer, Irish Health Research Board

2003-2006: Reviewer, Columbia University's "Improving Mental Health for Minority Populations" annual grant

### **Journal Peer Review Activities**

Peer review for *New England Journal of Medicine*; *JAMA*; *Lancet*; *Annals of Internal Medicine*; *Health Affairs*; *American Journal of Epidemiology*; *PLoS ONE*; *Medical Care*; *Canadian Medical Association Journal (CMAJ)*; *Annals of Epidemiology*; *International Journal of Epidemiology*;



*Journal of American Geriatric Society; American Journal of Managed Care; Pharmacoeconomics and Drug Safety; Journal of Health Care for the Poor and Underserved; Journal of Gerontology: Medical Sciences, Archives of General Psychiatry; JAMA-Psychiatry; American Journal of Psychiatry; British Journal of Psychiatry, Biological Psychiatry; Psychiatric Services; Acta Psychiatrica Scandinavica, Bipolar Disorders; Psychological Medicine; Schizophrenia Bulletin; Lancet-Psychiatry; Schizophrenia Research; Journal of Affective Disorders; Harvard Review of Psychiatry; Drug and Alcohol Dependence; Addiction; Journal of Addiction Medicine; Psychotherapy and Psychosomatics; Journal of Nervous and Mental Disease; Mental Health Services Research; Research, Administration and Policy in Mental Health and Mental Health Services Research; Psychological Bulletin; Social Psychiatry and Psychiatric Epidemiology; Journal of Psychosomatic Research; Child and Adolescent Mental Health; European Psychiatry; Journal of Women's Health; Depression & Anxiety; Suicide and Life-Threatening Behavior; Journal of Child Psychology and Psychiatry; Health Economics*

### **Other Peer Review Activities**

2011-2018: Peer reviewer for the American Public Health Association annual meeting submissions,

2015: Peer reviewer for *UpToDate*® psychiatry articles

### **HONORS AND AWARDS**

Klerman Award, National Alliance for Research on Schizophrenia and Depression (NARSAD), 2003.

The International Medical Graduate Fellowship Award, American Association of Directors of Psychiatric Residency Training (AADPRT), 2007.

Laughlin Fellowship Award, American College of Psychiatrists (ACP), 2008.

Advising, Mentoring & Teaching Recognition Award (AMTRA), Johns Hopkins Bloomberg School of Public Health, 2019-2020

Listed in the Stanford top 2% world scientists list for 2020-2023

(<https://doi.org/10.1371/journal.pbio.3000918>.)

Listed among the top scientists by Research.com in the fields of Psychology and Medicine

(<https://research.com/>)

### **PUBLICATIONS**

#### **Peer-Reviewed Journal Articles**

1. **Mojtabai, R.** (1994). Fregoli syndrome. *Australian and New Zealand Journal of Psychiatry*, 28:458-462
2. **Mojtabai, R.**, Nicholson, R.A. (1995). Interrater reliability of ratings of delusion and bizarre delusion. *American Journal of Psychiatry*, 152:1804-1806
3. **Mojtabai, R.** (1996). Misidentification phenomena in German psychiatry: A historical review and comparison with French/English tradition. *History of Psychiatry*, 7:137-159
4. **Mojtabai, R.**, Nicholson, R.A., Neesmith, D.H. (1997). Factors affecting relapse in patients discharged from a public hospital: Results from survival analysis. *Psychiatric Quarterly*, 68:117-129
5. **Mojtabai, R.**, Nicholson, R.A., Carpenter, B.N. (1998). Role of psychosocial treatments in management of schizophrenia: A meta-analytic review of controlled outcome studies. *Schizophrenia Bulletin*, 24:569-587
6. **Mojtabai, R.** (1998). Identifying misidentifications: A phenomenological study. *Psychopathology*, 31: 90-95
7. Susser, E., Varma, V.K., Mattoo, S.K., Finnerty, M., **Mojtabai, R.**, Tripathi, B.M., Misra, A.K., Wig, N.N. (1998). Long-term course and nosology of acute brief psychosis: Results from a developing country setting. *British Journal of Psychiatry*, 173: 231-236
8. **Mojtabai, R.**, Rieder, R.O. (1998). Limitations of symptom-oriented approach in psychiatric research. *British Journal of Psychiatry*, 173:198-203
9. **Mojtabai, R.** (1999). Duration of illness and structure of symptoms in schizophrenia. *Psychological Medicine*, 29:915-924
10. Collins, P.Y., Varma, V.K., Wig, N.N., **Mojtabai, R.**, Day, R., Susser, E. (1999). Fever and acute brief psychosis in two developing country sites. *British Journal of Psychiatry*, 174:520-524
11. **Mojtabai, R.**, Bromet, E., Harvey, P.D., Carlson, G., Craig, T., Fennig, S. (2000). Neuropsychological differences between first-admission schizophrenia and psychotic affective disorders. *American Journal of Psychiatry*, 157:1453-1460
12. **Mojtabai, R.**, Varma, V.K., Susser E. (2000). Duration of remitting psychoses with acute onset: Implications for ICD-10. *British Journal of Psychiatry*, 176:576-580
13. **Mojtabai, R.** (2000). Delusion as error: The history of a metaphor. *History of Psychiatry*, 11:3-14
14. Susser, E., Finnerty, M., **Mojtabai, R.**, Yale, S., Conover, S., Goetz, R., Amador, X. (2000). Reliability of the Life Chart Schedule for assessment of the long-term course of schizophrenia. *Schizophrenia Research*, 42:67-77

15. **Mojtabai, R.** (2000). Heterogeneity of cycloid psychosis: A latent class analysis. *Psychological Medicine*, 30:721-726
16. **Mojtabai, R.** (2001). Residual symptoms and impairment in major depression in the community. *American Journal of Psychiatry*, 158:1645-1651
17. **Mojtabai, R.** (2001). Impairment in major depression: Implications for diagnosis. *Comprehensive Psychiatry*, 42:206-212
18. **Mojtabai, R.**, Varma, V.K., Malhotra, S., Mattoo, S.K., Misra, A.K., Wig, N.N., Susser, E. (2001). Mortality and long-term course in schizophrenia with a poor 2-year course: A study in a developing country. *British Journal of Psychiatry*, 178:71-75
19. **Mojtabai, R.**, Olfson, M., Mechanic, D. (2002). Perceived need and help-seeking in adults with mood, anxiety, or substance use disorders. *Archives of General Psychiatry* 59:77-84
20. **Mojtabai, R.** (2002). Diagnosing depression and prescribing antidepressants by primary care physicians: The impact of practice style variations. *Mental Health Services Research*, 4:109-118
21. **Mojtabai, R.**, Lavelle, J., Gibson, P.J., Sohler, N.L., Craig, T.J., Carlson, G.A., Bromet, E.J. (2002). Early gaps in antipsychotic medication use in first-admission schizophrenia: 1989-1996. *Psychiatric Services* 53:337-339
22. Carlson, G.A., Bromet, E.J., Driessens, C., **Mojtabai, R.**, Schwartz, J.E. (2002). Age of onset, childhood psychopathology, and 2-year outcome in psychotic bipolar disorder. *American Journal of Psychiatry* 159:307-309
23. Ghassemzadeh, H., **Mojtabai, R.**, Khamseh, A., Ebrahimkhani, N., Issazadegan, A., Saif-Nobakht, Z. (2002). Symptoms of obsessive-compulsive disorder in a sample of Iranian patients. *International Journal of Social Psychiatry* 48:20-28
24. **Mojtabai, R.**, Susser, E.S., Bromet, E.J. (2003). Clinical characteristics, four-year course and DSM-IV diagnosis of non-affective acute remitting psychosis. *American Journal of Psychiatry* 160:2108-2115
25. **Mojtabai, R.**, Lavelle, J., Gibson, P.J., Bromet, E. (2003). Atypical antipsychotics in first-admission schizophrenia: medication continuation and outcomes. *Schizophrenia Bulletin* 29:519-530
26. **Mojtabai, R.**, Olfson, M. (2003). Medication costs, adherence, and health outcomes among Medicare Beneficiaries. *Health Affairs* 22:220-229
27. **Mojtabai, R.**, Zivin, J. (2003). Effectiveness and cost-effectiveness of four treatment modalities for substance disorders: A propensity score analysis. *Health Services Research* 38 (part I):233-259

28. **Mojtabai, R.**, Rosenheck, R.A., Wyatt, R.J., Susser, E.S. (2003). Use of VA aftercare following military discharge among patients with serious mental disorders. *Psychiatric Services* 54:383-388
29. **Mojtabai, R.**, Malaspina, D., Susser, E.S. (2003). The concept of primary prevention: Application to schizophrenia. *Schizophrenia Bulletin* 29:791-801
30. Wyatt, R.J., Henter, I.D., **Mojtabai, R.**, Bartko, J.J. (2003). Height, weight, and Body Mass Index (BMI) in psychiatrically ill U.S. Armed Forces personnel. *Psychological Medicine* 33:363-368
31. Naz, B., Bromet, E.J., **Mojtabai, R.** (2003). Distinguishing between first-admission schizophreniform disorder and schizophrenia. *Schizophrenia Research* 62:51-58
32. **Mojtabai, R.** (2004). Which substance abuse treatment facilities offer dual diagnosis programs? *American Journal of Drug and Alcohol Abuse* 30:525–536
33. **Mojtabai, R.**, Olfson, M. (2004). Cognitive deficits and the course of major depression in a cohort of middle-aged and older adults in the community. *Journal of the American Geriatric Society* 52:1060-1069
34. Craig, T.J., Grossman, S., **Mojtabai, R.**, Gibson, P.J., Lavelle, J., Carlson, G.A., Bromet, E.J. (2004). Medication Use Patterns and 2-Year Outcome in First-Admission Bipolar Disorder with Psychotic Features. *Bipolar Disorder* 6:406-415
35. Sohler, N.L., Bromet, E.J., Lavelle, J., Craig, T.J., Fochtman, L., **Mojtabai, R.** (2004). Are there racial differences in the way patients with psychotic disorders are treated at their first hospitalization? *Psychological Medicine* 34:705-718
36. **Mojtabai, R.**, Olfson, M. (2004). Major Depression in community-dwelling middle-aged and older adults: Prevalence and 2- and 4-year follow-up symptoms. *Psychological Medicine* 34: 623-634
37. **Mojtabai, R.** (2004). Body mass index and serum folate in childbearing age women. *European Journal of Epidemiology* 19:1029-1036
38. **Mojtabai, R.**, Herman, D., Susser, E.S., Sohler, N., Craig, T.J., Lavelle, J., Bromet, E.J. (2005). Service use and outcomes of first-admission patients with psychotic disorders in the Suffolk County Mental Health Project. *American Journal of Psychiatry*, 162:1291-1298
39. **Mojtabai, R.** (2005). Trends in help-seeking from mental health professionals and cost barriers to mental health care among adults with significant psychological distress in the US: 1997-2002. *American Journal of Public Health*, 95:2009-2014
40. **Mojtabai, R.** (2005). Compliance with mental health and other specialty care referrals among Medicare/Medicaid dual enrollees. *Community Mental Health Journal*, 41:339-344

41. **Mojtabai, R.** (2005). Use of specialty substance abuse and mental health services in adults with substance use disorders in the community. *Drug and Alcohol Dependence*, 78:345-354
42. **Mojtabai, R.** (2005). Parental psychopathology and childhood atopic disorders in the community. *Psychosomatic Medicine*, 67:448-453
43. **Mojtabai, R.** (2005). Perceived reasons for loss of housing and continued homelessness among homeless mentally ill individuals. *Psychiatric Services*, 56:172-178
44. Bromet, E.J., Finch, S.J., Carlson, G.A., Fochtmann, L., **Mojtabai, R.**, Craig, T. J., Kang, S., Ye, Q. (2005). Time to remission and relapse after the first hospital admission in severe bipolar disorder. *Social Psychiatry and Psychiatric Epidemiology*, 40:106–113
45. Ghassemzadeh, H., **Mojtabai, R.**, Karamghadiri, N., Ebrahimkhani, N. (2005). Psychometric properties of a Persian language version of the Beck Depression Inventory-Second Edition: BDI-II-Persian, *Depression & Anxiety*, 21:185-192
46. Herrell, R., Henter, I. D., **Mojtabai, R.**, Bartko, J. J., Venable, D., Susser, E., Merikangas, K. R., Wyatt, R. J. (2006). First psychiatric hospitalization in the U.S. military: The National Collaborative Study of Early Psychosis and Suicide (NCSEPS). *Psychological Medicine*, 36:1405-1415
47. **Mojtabai, R.** (2006). Serious emotional and behavioral problems and mental health contacts in American and British children and adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry*, 45:1215-1223
48. **Mojtabai, R.**, Olfson, M. (2006). Treatment seeking for depression in Canada and the United States. *Psychiatric Services*, 57: 631-639
49. Ghassemzadeh, H., **Mojtabai, R.**, Karamghadiri, N., Ebrahimkhani, N. (2006). Psychometric properties of a Persian language version of the Automatic Thoughts Questionnaire: ATQ-Persian. *International Journal of Social Psychiatry*, 52:129-139
50. **Mojtabai, R.** (2006). Psychotic-like experiences and interpersonal violence in the general population. *Social Psychiatry and Psychiatric Epidemiology*, 41:183-190
51. Cohen, L. J., Frenda, S., **Mojtabai, R.**, Katasavdakis, K., Galynker, I. I. (2007). Comparison of sexual offenders against children to sexual offenders against adolescents and adults. *Journal of Psychiatric Practice*, 13:373-384
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#### **Book Reviews:**

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7. Eaton, W.W., **Mojtabai, R.**, Stuart, E.A., Leoutsakos, J-M S., Kuramoto, S.J. (2012). Assessment of distress, disorder, impairment and need in the population. In Eaton, W.W. (Ed.) *Public Mental Health*. New York, Oxford University Press.
8. **Mojtabai, R.** (2016). Common themes and divergent views on heterogeneity in long-term course and outcome of adult mental and substance disorders. In Bromet, E.J. (Ed.) *Long-Term Outcomes in Psychopathology Research*. Oxford University Press.
9. **Mojtabai, R.**, Fochtmann, L.J., Bromet E.J. (2017). Other psychotic disorders. In Sadock, B.J., Sadock, V., Ruiz, P. (Eds). *Comprehensive Textbook of Psychiatry*, 10<sup>th</sup> Edition. New York: William & Wilkins.
10. **Mojtabai, R.**, Murray, S., Eaton, W.W. (2019). Pathways to care: Need, attitudes, barriers. In Eaton, W.W., Fallin, M.D. (Ed.) *Public Mental Health, 2<sup>nd</sup> Edition*. New York, Oxford University Press.
11. Eaton, W.W., **Mojtabai, R.**, Stuart, E.A., Leoutsakos, J.S., Myllyluoma, J. (2019). Assessment of distress, disorder, impairment and need in the population. In Eaton, W.W., Fallin, M.D. (Ed.) *Public Mental Health, 2<sup>nd</sup> Edition*. New York, Oxford University Press.
12. **Mojtabai, R.**, Fochtmann, L.J., Bromet E.J. (2024). Other psychotic disorders. In Boland, R., Verduin, M.L. (Eds). *Kaplan and Sadock's Comprehensive Textbook of Psychiatry*, 11<sup>th</sup> Edition. New York: William & Wilkins.

#### **Practice Guidelines:**

1. Keepers, G.A., Fochtmann, L.J., Anzia, J.M., Benjamin, S., Lyness, J.M., **Mojtabai, R.**, Servis, M., Walaszek, A., Buckley, P., Lenzenweger, M.F., Young, A.S., Degenhardt, A. (2020). *American Psychiatric Association Practice Guideline for the Treatment of Patients with Schizophrenia*. American Psychiatric Association, Washington, DC.  
<https://psychiatryonline.org/doi/pdf/10.1176/appi.books.9780890424841>

2. Keepers, G.A., Fochtmann, L.J., Anzia, J.M., Benjamin, S., Lyness, J.M., **Mojtabai, R.**, Servis, M., Walaszek, A., Buckley, P., Lenzenweger, M.F. and Young, A.S., Degenhardt, A. (2020). The American Psychiatric Association Practice Guideline for the Treatment of Patients with Schizophrenia. *American Journal of Psychiatry*; 177: 868-872 (reprinted in: *Focus*, 2020;18:493-497)..
3. Keepers, G.A., Fochtmann, L.J., Anzia, J.M., Benjamin, S., Lyness, J.M., **Mojtabai, R.**, Servis, M., Choi-Kain, L., Nelson, K.J., Oldham, J.M., Sharp, C., Degenhardt, A., Fochtmann, L.J., Oldham, J.M., Hong, S.H., Medicus, J. (2024). The American Psychiatric Association Practice Guideline for the Treatment of Patients with Borderline Personality Disorder. *American Journal of Psychiatry*. 181:1024-1028
4. Keepers, G.A., Fochtmann, L.J., Anzia, J.M., Benjamin, S., Lyness, J.M., Mojtabai, R., Servis, M., Choi-Kain, L., Nelson, K.J., Oldham, J.M., Sharp, C., Degenhardt, A., Fochtmann, L.J., Oldham, J.M., Hong, S.H., Medicus, J. (2025). *The American Psychiatric Association Practice Guideline for the Treatment of Patients with Borderline Personality Disorder, Second Edition*. American Psychiatric Association, Washington, DC.

#### Web-Based Medical References:

1. **Mojtabai, R.** (2014-). Brief psychotic disorder. In *UpToDate*®. Wolters Kluwer Health. <http://www.uptodate.com/contents/brief-psychotic-disorder>
2. **Mojtabai, R.**, Paul Nestadt, MD (2016-). Brief psychotic disorder. In *Johns Hopkins POC-IT Guides-Psychiatry*, Unbound Medicine Inc. [http://www.hopkinsguides.com/hopkins/view/Johns\\_Hopkins\\_Psychiatry\\_Guide/787041/all/Brief%20Psychotic%20Disorder](http://www.hopkinsguides.com/hopkins/view/Johns_Hopkins_Psychiatry_Guide/787041/all/Brief%20Psychotic%20Disorder)

Pubmed link: <https://www.ncbi.nlm.nih.gov/pubmed/?term=Mojtabai+R>

Google Scholar link: <https://scholar.google.com/citations?user=m7zi048AAAAJ&hl=en&oi=ao>

### CURRICULUM VITA

Ramin Mojtabai

Part II

### TEACHING

#### Advisees

Erin Masterson, iMPH student, 2010-2011

Rachel Hingst, MPH student, 2010-2011

Katie Bonebrake (Nugent), PhD student, Department of Mental Health, JHSPH, 2009-2011  
 Ruben Miozzo, MD, PhD student, Department of Mental Health, JHSPH, 2010-2011  
 Chris Kaufmann, PhD student, Department of Mental Health, JHSPH, 2010-2015  
 Lian-Yu Chen, MD, PhD student, Department of Mental Health, JHSPH, 2011-2014  
 Tshering Dolkar, MA, Hubert Humphrey Fellow, JHSPH, 2011-2012  
 Julia Zur, PhD student, Department of Mental Health, JHSPH, 2010-2012 (graduated 2012)  
 Dawn Corbett, MPH student, 2012-2014 (graduated 2014)  
 Vandad Sharifi, MD, Post-doctoral fellow, Department of Mental Health, JHSPH 2013-2014  
 Pia Mauro, PhD student, Department of Mental Health, JHSPH, 2013-2015  
 Nadiya Sunderji, MD, iMPH student, 2012-2016  
 Fatima Mohiuddin, iMPH student, 2015-208  
 Liming Dong, MD, MHS, PhD student, 2014-2016 (graduated 2016)  
 Arnob Chakraborti, MD, MPH student, 2016-2019  
 Noa Krawczyk, PhD student, 2015-2019  
 Paul Nestadt, MD, Post-doctoral fellow at the Psychiatric Epidemiology Training Program, 2016-2018  
 Kayla Tromohlen, PhD student, 2016-2020  
 Kira Rhiem, PhD student, 2017-  
 Ahmed Hassib, MD, MPH, 2016-2017  
 Brittany L. Parmentier, PharmD., BCPS, MPH candidate, 2017-2019  
 Brady Garret, PhD, MPH student, 2017-2021  
 Billina Shaw, MD, MPH student, 2018-2021  
 Catherine Tomko, PhD, Post-doctoral fellow at the Drug Dependence Epidemiology Training Program, 2020-  
 Amanda Luken, PhD student, 2020-2024

### **Master's Capstone advising**

Chris Kaufmann, MHS candidate, Department of Mental Health, JHSPH, 2010  
 Jessy Warner-Cohen, MPH candidate, JHSPH, 2010  
 Rachel Hingst, MPH candidate, JHSPH, 2011  
 Hillary Samples, MHS candidate, Department of Mental Health, 2013  
 Jennay Ghorwal, MHS candidate, Department of Mental Health, 2013  
 Emily Metzger, MHS candidate, Department of Mental Health, 2015  
 Michael Sullivan Phillips, MHS candidate, Department of Mental Health, 2020



Brady Garrett, PhD, MPH candidate, Bloomberg American Health Initiative, 2021

### **Preliminary Doctoral Thesis Oral Examination**

Lareina La Flair, Department of Mental Health, JHSPH, 2009

Janet Kuramoto, Department of Mental Health, JHSPH, 2009

Katie Bonebrake (Nugent), Department of Mental Health, JHSPH, 2010

Namrita Singh, Department of International Health, JHSPH, 2010

Etheldreda Nakimuli-Mpungu, Department of Mental Health, JHSPH, 2010

Itziar Familiar, Department of Mental Health, JHSPH, 2011

Mary (Beth) McGinty, Department of Health Policy and Management, 2011 (chair)

Diana Paksarian, Department of Mental Health, 2012 (chair)

Megan Schuler, Department of Mental Health, 2012

Lauren Ropelewski, Department of Mental Health, 2012 (chair)

Lian-Yu Chen, MD, PhD candidate, Department of Mental Health, JHSPH, 2012

Laysa Ostrow, PhD candidate, Department of Mental Health, JHSPH, 2013

Elizabeth Pfoh, PhD candidate, Department of Health Policy and Management, JHSPH, 2013 (chair)

Angela Lee-Winn, PhD candidate, Department of Mental Health, JHSPH, 2014

Pia Mauro, PhD candidate, Department of Mental Health, JHSPH, 2015 (advisor)

Liming Dong, MD, MHS, PhD candidate, Department of Mental Health, 2015 (advisor)

Lamar Hunt, PhD candidate, Department of Epidemiology, JHSPH, 2018 (chair)

Benjamin Ackerman, PhD candidate, Department of Biostatistics, JHSPH, 2018

Kenneth Feder, PhD candidate, Department of Mental Health, 2018

Noa Krawczyk, PhD candidate, Department of Mental Health, 2018 (advisor)

Kayla Tormohlen, PhD candidate, Department of Mental Health, 2019 (advisor)

Sherri-Chanelle Brighthaupt, Department of Mental Health, JHSPH, 2019

Trang Quynh Nguyen, PhD, PhD candidate, Department of Biostatistics, 2020

Rachel Presskreischer, PhD candidate, Department of Health Policy and Management, 2020 (chair)

Kayla Tormohlen, Department of Mental Health, JHSPH, 2020 (advisor)

Kira Riehm, PhD candidate, Department of Mental Health, JHSPH, 2020 (advisor)

Ben Hamlin, DrPH candidate, Department of Health Policy and Management, JHSPH, 2020 (chair)

Luke Aldrich, PhD candidate, Department of Mental Health, JHSPH, 2020

Courtney Nordeck, PhD candidate, Department of Mental Health, JHSPH, 2021

Amanda Luken, PhD candidate, Department of Mental Health, 2023

Nicole McConico, PhD candidate, Department of Mental Health, 2023

### **Final Doctoral Thesis Oral Examination**

Rufina JiYoung Lee, School of Social Work, Columbia University, 2006

Katie Bonebrake (Nugent), Department of Mental Health, JHSPH, 2011 (advisor)

Janet Kuramoto, Department of Mental Health, JHSPH, 2011

Etheldreda Nakimuli-Mpungu, Department of Mental Health, JHSPH, 2011

Waleed Zafar, Department of Health, Behavior and Society, JHSPH, 2012 (chair)

Julia Zur, Department of Mental Health, JHSPH, 2012 (advisor)

Rachana Sikka, Department of Health, Behavior and Society, JHSPH, 2012 (chair)

Mary (Beth) McGinty, Department of Health Policy and Management, JHSPH, 2013

Edward Hammond, Department of Epidemiology, JHSPH, 2013

Diana Paksarian, Department of Mental Health, JHSPH, 2013

Elizabeth Pfoh, Department of Health Policy and Management, JHSPH, 2014 (chair)

Lian-Yu Chen, Department of Mental Health, JHSPH, 2014 (advisor)

Pia Mauro, Department of Mental Health, JHSPH, 2015 (advisor)

Liming Dong, Department of Mental Health, JHSPH, 2016 (advisor)

Remington Nevin, Department of Mental Health, JHSPH, 2016

Hillary Samples, Department of Health Policy and Management, JHSPH, 2017 (chair)

Ryoko Susukida, Department of Mental Health, JHSPH, 2017

Roza Vazin, Department of Health Policy and Management, JHSPH, 2018 (chair)

Keneth Feder, Department of Mental Health, JHSPH, 2019

Aravind Pillai, Department of Epidemiology, School of Public Health, Columbia University, 2019

Noa Crawczyk, Department of Mental Health, JHSPH, 2019 (advisor)

Kayla Tormohlen, Department of Mental Health, JHSPH, 2020 (advisor)

Sherri-Chanelle Brighthaupt, Department of Mental Health, JHSPH, 2020

Bingkai Wang, Department of Biostatistics, JHSPH, 2021 (chair)

Rachel Presskreischer, Department of Health Policy and Management, JHSPH, 2021 (chair)

Kira Riehm, Department of Mental Health, JHSPH (advisor)

Trang Quynh Nguyen, Department of Biostatistics, JHSPH, 2021 (chair)

Ben Hamlin (DrPH), Department of Health Policy and Management. JHSPH, 2021

Melanie Askari, Department of Epidemiology, Columbia University, 2022

Amenda Luken, Department of Mental Health, Johns Hopkins Bloomberg School of Public Health, JHSPH, 2024

### **Master's thesis evaluation**

Renee Goodwin, MPH candidate, Department of Epidemiology, School of Public Health, Columbia University, New York, NY, 2001

Ashley R. Jaramillo, MHS candidate, Department of Mental Health, JHSPH, 2010

Adam Hoffberg, MHS candidate, Department of Mental Health, JHSPH, 2011

Fabiola Ramos, MHS candidate, Department of Mental Health, JHSPH, 2011

Haley Deutch, MHS candidate, Department of Mental Health, JHSPH, 2012

Yoon-Kyu Sung, MHS candidate, Department of Epidemiology, JHSPH, 2013

Shiyin Jiao, MHS candidate, Department of Epidemiology, JHSPH, 2016

Mark Kealhofer, ScM candidate, Department of Epidemiology, JHSPH, 2017

Michael Sullivan Phillips, MHS candidate, Department of Mental Health, JHSPH, 2020

Brady Garrett, PhD, Bloomberg American Health MPH candidate, JHSPH, 2021

### **Classroom/Online Instruction**

**2025-Present:** Quality improvement (lecture series and project supervision for Triple-Board and Child Psychiatry Fellowship Program, Department of Psychiatry and Behavioral Sciences, Tulane University School of Medicine)

**2024-Present:** "Landmark Studies" (Guided reading for PGY1 class co-led with PGY 3's, Department of Psychiatry and Behavioral Sciences, Tulane University School of Medicine)

**2009-2024:** "Introduction to Mental Health Services" Johns Hopkins Bloomberg School of Public Health

**2013-present:** Coursera free online course: "Major Depression in the Population: A Public Health Approach" in collaboration with W.W. Eaton and W.A. Tol (Link: <https://www.coursera.org/course/pmhdepression>)

**2022** Educational Medscape presentation: "*Inertia In Major Depressive Disorder: A Journey Of A Thousand Miles Begins With A Single Step*" in collaboration with E. Vieta and B. Pennix (Link: <https://www.medscape.org/viewarticle/968888>)

**2011 and 2012:** "Introduction to Mental Health Services" Fall Institute, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Barcelona, Spain

**2010-2012:** Online course: "A Brief Introduction to Public Health for Mental Health Clinicians"  
Johns Hopkins School of Public Health

**2009:** Lectures in the school-wide "Public Health Perspectives" course

**2007-2008:** Psychiatry for medical students, Department of Psychiatry, Beth Israel Medical Center/Albert Einstein College of Medicine, New York, NY (course taught in collaboration with faculty and fellows for medical student from St Georges Medical School rotating in psychiatry)

**1992-1995:** As Teaching Assistant to Mary Ellen O'Conner, Ph.D., at the Department of Psychology, University of Tulsa (Tulsa, OK), assisted her in teaching undergraduate and graduate courses in biological psychology and psychopharmacology.

## **RESEARCH GRANT PARTICIPATION**

### **Active**

"Short-term Outcome of Stimulant Use Disorder Treatment Trials"; R01DA054700; Sponsor: NIDA 2022-2025; Total cost: \$ 1,228,125 (Role: PI); 3 calendar months

"Substance Use Treatment Outcomes: Effect of Psychiatric Comorbidity"; 1R01DA058008-01 , NIDA 2023-2026; Total cost: \$ 1,215,000 (Role: MPI with Rosa Crum); 2.4 calendar months

"Treatment Effect Heterogeneity in Psychosocial Treatments for Substance Use Disorders"; R01DA053202; NIDA 2022-2025; Total cost: \$1,215,000 (Role: Co-I; PI: Ryoko Susukida); 0.6 calendar months, in kind

### **Inactive**

"Health Care Policy and Substance Abuse Treatment Access"; R01DA039137; Sponsor: NIDA 2017-2023; Total cost: \$2,641,240 (Role: MPI with Mark Olfson, MD, MPH); 3.24 calendar months

"Clean Indoor Air Laws, Cigarette Taxes, and Use of Smoking Cessation Treatments"; R01DA042738; NIDA 2017-2022; Total funds requested: \$1,620,000 (Role: PI); 3.0 calendar months

"Prenatal SSRI Exposure, Maternal & Child Genotype, and Autism Spectrum Disorders"; 1R01HD087915; NICHD 2016-2021; Total direct cost (for subcontract to Hopkins): \$360,000

(Role: Co-I; PI: Lisa Croen, PhD), 0.36 calendar months

“Harmonizing Data from Drug Abuse Treatment Clinical Trials at National Institute of Drug Abuse”; Sponsor: Arnold Ventures, 2018-2020; Total cost: \$500,000 (Role: PI); 1 calendar month

“The Impact of State Healthcare Reforms on Treatment of Substance Use Disorders”; R01 DA039863; Sponsor: NIDA, 2016-2020; Total direct cost: \$450,000 (Role: MPI with Rosa Crum, MD, MHS); 2.4 calendar months

“Risks and Protective Factors for Unintended Pregnancy in Women with Disabilities”; R21 HD086471; Sponsor: NINR, 2016-2018; Total direct cost: \$275,000 (Role: Co-I; PI: Jean Alhusen, PhD), 0.6 calendar months

“Generalizing RCT Efficacy Evidence: Application to NIDA Clinical Trials Network”; R01 DA036520; Sponsor: NIDA, 2014-2017; Total direct cost: \$490,000 (Role: PI); 2.4 calendar months

“Hybrid Trial of Collaborative Child Mental Health Care in Iran”; R34MH106645; Sponsor: NIMH, 2016-2020; Total direct cost: \$ 450,000 (Role: PI), 1.8 calendar months

“Texting for Relapse Prevention: Improving outcomes for people with schizophrenia”; 1R34MH108781-01A1; Sponsor: NIMH, 2016-2018; Total direct cost: \$330,000 (Role: Co-I; MPI: Bernadette Goggins, MD/Michelle Ybarra, PhD), 0.12 calendar months

“Social Consequences of Mental Disorders: A Ten-Year Follow-up Study”; R01 MH096826-01A1; Sponsor: NIMH, 2013-2015; Total cost: \$566,000 (Role: PI); 2.4 calendar months

“Treatment Patterns and Barriers in Comorbid Mental and Substance Disorders”; R01 DA030460; Sponsor: NIDA, 2010-2014; Total direct cost: \$490,000; (Role: PI); 3.0 calendar months

“Impact of Employment Interventions for Persons with Serious Mental Illnesses on Non-employment Patient-Centered Outcomes”; HSA290201000009I, Sponsor: AHRQ, 2011-2013;

Total direct cost \$966,134 (Role: Co-investigator, PI: Donald Steinwachs, PhD); 0.48 calendar months

“The Mental Health, Mental Health Care Needs and Mental Health Help Seeking in First Responders”; Sponsor: Johns Hopkins Preparedness and Emergency Response Research Center; 2010-2011. Total direct cost: \$30,000; (Role: PI); 1.2 calendar months

“Real World Assessment of Higher Functioning in Individuals with Schizophrenia and Schizoaffective Disorder Living in Community Settings”; sponsor: Bristol-Myers Squibb, 2006-2008, Total direct cost: \$343,116; (Role: PI); 3 calendar months

“Continuity of Care and Outcomes in First-Admission Severe Mental Disorders”. Mentored Research Scientist Career Award (K01), NIMH, 1999-2004. Direct support \$ 693,353 (Role: PI).

“Continuity of Care and Outcome in First-Admission Schizophrenia”. Young Investigator Award, National Alliance for Research on Schizophrenia and Depression (NARSAD), 1999-2001. Direct support \$ 60,000 (Role: PI).

### **Past Training Grant Participation**

“Mental Health Services and Systems Training Program”; T32MH109436; Sponsor: NIMH, 2021-2028 (Role: MPI with Stuart, E.S.)

“Drug Dependence Epidemiology Training Program”; T32DA007292; Sponsor: NIDA; 1005-2023 (MPI: Johnson R./Maher, B., Role: Core Director).

“Psychiatric Epidemiology Training (PET) Program”; T32MH014592; Sponsor: NIMH; 1976-2023 (MPI: Zandi, P./Volk, H., Role: Core Faculty, Mental Health Services concentration; Member, Advisory Committee).

### **Mentoring on individual training grants and K-Awards**

“Harmonizing multiple data sources and psychological autopsy to characterize suicides among opioid-related deaths.” 1K23DA055693-01; PI: P. Nestadt: 2022-2027, Total direct cost: \$990,000 (Role: Mentor 2022-2024).



“Sedative-hypnotic use in US older adults: Recent trends and associated outcomes.”

F31AG044052; PI: C. Kaufmann; 2013-2016; Total direct cost: \$82,000 (Role: Mentor).

“Assessing the relationship between opioid agonist therapy and risk of overdose and criminal justice involvement in Maryland: A population-based approach” F31DA047021; PI: N. Krawczyk; 2018; Total direct cost: \$44,000 (Role: Mentor).

“The Effects of Children’s Use of Mental Health Services on Later Adolescent Substance Use.” NARSAD Young Investigator Award; PI: A. Young; 2018-2020; Total direct cost: \$70,000 (Role: Mentor).

“Estimating population effects in mental health research using meta-analysis” K99MH111807; PI: Hong, H; 2017-2019; Total direct cost: \$220,000 (Role: Mentor).

“Preventive Effects of Treatment for Childhood Mental Illness on Adolescent Substance Use.” K23 DA 44288; PI: Young, A.; 2018-2023; Total direct cost: \$750,000 (Role: Co-Mentor).

“Real-world complexities in opioid use disorder treatment: understanding family comorbidity, high-risk medication use, and costs related to treatment adherence and health outcomes.” K01 DA 054359; PI: Seamanns, M.J.; 2022-2026; Total direct cost: \$750,000 (Role: Co-Mentor).

## **ACADEMIC SERVICE**

### **School-wide**

Member, Human Protection Committee-Full Committee (IRB-FC), JHSPH, Oct. 2009-Present

Member, Committee on Equity, Diversity and Civility, JHSPH, Sept. 2011- Dec. 2015

Co-Chair, Committee on Equity, Diversity and Civility, JHSPH, Dec. 2015-2018

### **Departmental**

Coordinator of Mental Health Services course series, 2009-Present

Curriculum Committee, 2013-Present

MHS Steering Committee, 2019-Present

### **Participation in Research Centers**

Faculty member, Center for Mental Health Initiatives, Department of Mental Health, 2008-

present

Core faculty member, Center for Drug Safety and Effectiveness, Departments of Epidemiology and Medicine, 2010-present

Deputy Director, Center for Mental Health and Addiction Policy Research, Departments of Mental Health and Health Policy and Management, 2016-2019

## **SELECTED ORAL PRESENTATIONS**

### **Invited Talks**

2025: "Craving in Psychostimulant Use Disorders" Grand Rounds, Department of Psychiatry and Behavioral Sciences, Tulane University School of Medicine, April 2025

2021: "The Impact of Affordable Care Act on Substance Use Treatments" presented at the Substance Use Epidemiology Training Program seminar series, Department of Epidemiology, Columbia University, May 2021.

2018: "Management of common medical conditions by office-based psychiatrists" presented in the workshop: Psych Services Says and You Can Do! at National Council for Behavioral Health annual meeting, Washington, DC, April 2018.

2015: "Dean's Lecture: Has increased provision of mental health treatments reduced the prevalence of common mental disorders?" Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, Sept. 2015.

2015: "To screen or not to screen? Debate on depression screening in primary care". Welch Center, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, Oct. 2015.

2015: "Population trends in the use of mental health treatments and mental health outcomes". Department of Pharmaceutical Health Service Research, School of Pharmacy, University of Maryland, Baltimore, MD, Nov. 2015.

2013: Chair and Discussant: "Session I: Long-term outcomes of adult clinical disorders" 103rd Annual Meeting of the American Psychopathological Association, New York, NY, Mar. 2013.

2012: "Bereavement-Related Depressive Episodes in DSM-5." Grand Rounds at the Department of Psychiatry, Beth Israel Medical Center, New York, NY, Feb. 2012.

2012: "Characteristics and three-year course of bereavement-related depressive episodes: A longitudinal community-based study in the US." The 165<sup>th</sup> Annual Meeting of the American Psychiatric Association, Philadelphia, PA, May 2012.

- 2012: "Antidepressants and diabetes: Is there a link?" Grand Rounds at the Department of Psychiatry and Behavioral Sciences, State University of New York, Stony Brook, NY, Oct. 2012.
- 2011: "Association of perceived treatment need and barriers with future treatment seeking for substance disorders: Results from the National Epidemiologic Survey on Alcohol and Related Conditions." The 139<sup>th</sup> Annual Meeting of the American Public Health Association, Washington, DC, Oct. 2011.
- 2010: "Trends in Polypharmacy in Outpatient Psychiatry". Institute of Health, Health Care Policy and Aging Research (IHCPAR), Rutgers University, New Brunswick, NJ. April 2010.
- 2007: "Trends in antidepressant medication use in the community". Grand Rounds, Department of Psychiatry, Maimonides Medical Center, Brooklyn, NY, Oct. 2007.
- 2005: "Effectiveness of treatments in schizophrenia: The challenge of non-adherence". The 13<sup>th</sup> World Congress of Psychiatry, Cairo, Egypt, Sept. 2005.
- 2004: "Care and outcomes of first-admission psychotic disorders in the 1990s." Institute of Health, Health Care Policy and Aging Research (IHCPAR), Rutgers University, New Brunswick, NJ. April 2004.
- 2004: "Treatment careers of patients with first-admission psychotic disorders in 1990s". Grand Rounds at Creedmore Psychiatric Hospital, NY. May 2004.
- 2004: "Refining the definition of acute and transient psychotic disorders (ATPD)". The 12<sup>th</sup> Annual meeting of the Association of European Psychiatrists (AEP), Geneva, Switzerland, April 2004. Abstracted in *European Psychiatry*, 19 Supplement 1:108s, 2004)
- 2001: "Challenges in defining 'true' psychiatric disorders in community studies: The case of major depression". Institute of Health, Health Care Policy and Aging Research (IHCPAR), Rutgers University, New Brunswick, NJ. Nov. 2001.

# Exhibit C

### **Materials Considered**

1. 5Rights Foundation. (2021). Pathways: How Digital Design Puts Children At Risk. <https://5rightsfoundation.com/wp-content/uploads/2021/09/Pathways-how-digital-design-puts-children-at-risk.pdf>
2. ABC Action News. (2024, February 3). Timeline: Looking back at 20 years of Facebook and CEO Mark Zuckerberg. CNNWire. <https://6abc.com/facebook-20-year-anniversary-mark-zuckerberg-meta/14383883/#:~:text=September%202005%20%2D%20Facebook%20expands%20into,settles%20their%20lawsuit%20against%20Zuckerberg.>
3. Abi-Jaoude, E., Naylor, K. T., & Pignatiello, A. (2020). Smartphones, social media use and youth mental health. *CMAJ: Canadian Medical Association journal = journal de l'Association medicale canadienne*, 192(6), E136–E141.
4. Aboraya, A., Rankin, E., France, C., El-Missiry, A., & John, C. (2006). The Reliability of Psychiatric Diagnosis Revisited: The Clinician's Guide to Improve the Reliability of Psychiatric Diagnosis. *Psychiatry (Edgmont (Pa. : Township))*, 3(1), 41–50.
5. Abrams, Z. (2022, February 3). Why young brains are especially vulnerable to social media. The science behind why apps like TikTok, Instagram, and Snapchat impact your child's brain in a different way than your adult brain. APA Article. <https://www.apa.org/news/apa/2022/social-media-children-teens>
6. Abrams, Z. (2022, February 3). Why young brains are especially vulnerable to social media. The science behind why apps like TikTok, Instagram, and Snapchat impact your child's brain in a different way than your adult brain. APA Article. <https://www.apa.org/news/apa/2022/social-media-children-teens>
7. Academy for Eating Disorders. (2021, November 2). Urgent Responsibility to Reduce Harms Posed by Social Media on risk for Eating Disorders: An Open Letter to Facebook, Instagram, TikTok, and Other Global Social Media Corporations. Newswise. <https://www.newswise.com/articles/urgent-responsibility-to-reduce-harms-posed-by-social-media-on-risk-for-eating-disorders>
8. Achenbach, T.M. (1978). The Child Behavior Profile: An Empirically Based System for Assessing Children's Behavioral Problems and Competencies. *International Journal of Mental Health*, 7, 24-42.
9. Achieve your business goals with TikTok for Business. TikTok for Business. <https://web.archive.org/web/20230606040533/www.tiktok.com/business/en-US/blog/tiktok-drives-greater-audience-engagement>
10. Ackerman, B., Schmid, I., Rudolph, K. E., Seamans, M. J., Susukida, R., Mojtabai, R., & Stuart, E. A. (2019). Implementing statistical methods for generalizing randomized trial findings to a target population. *Addictive Behaviors*, 94, 124–132. <https://doi.org/10.1016/j.addbeh.2018.10.033>
11. Adeyanju, G. C., Solfa, R. P., Tran, T. L., Wohlfarth, S., Buttner, J., Osobajo, O. A. & Otitoju, A. (2021). Behavioural symptoms of mental health disorder such as depression among young people using Instagram: a systematic review. *Translational Medicine Communications*, 6:15.
12. Adinoff, B. (2004). Neurobiologic processes in drug reward and addiction. *Harvard Review of Psychiatry*, 12(6), 305–320. <https://doi.org/10.1080/10673220490910844>

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#### **Depositions**

757. Deposition transcript and exhibits of Ryn Linthicum, 4/17/2025
758. Deposition Transcripts and Exhibits of Adam Mosseri, 3/17/2025
759. Deposition Transcripts and Exhibits of Adam Mosseri, 3/18/2025
760. Deposition Transcripts and Exhibits of Arturo Bajar, 4/7/2025
761. Deposition Transcripts and Exhibits of Arturo Bajar, 4/8/2025
762. Deposition Transcripts and Exhibits of Arturo Bajar, 4/9/2025
763. Deposition transcripts and Exhibits of Aza Raskin, 3/17/2025
764. Deposition Transcripts and Exhibits of Darius Kilstein, 12/17/2024
765. Deposition Transcripts and Exhibits of Darius Kilstein, 12/18/2024
766. Deposition Transcripts and Exhibits of Diego Castaneda, 10/22/2024
767. Deposition Transcripts and Exhibits of Diego Castaneda, 10/23/2024
768. Deposition Transcripts and Exhibits of George Volichenko, 12/16/2024
769. Deposition Transcripts and Exhibits of George Volichenko, 12/17/2024
770. Deposition Transcripts and Exhibits of Jennifer Guadagno, 11/14/2024
771. Deposition Transcripts and Exhibits of Kang-Xing Jin, 10/24/2024
772. Deposition Transcripts and Exhibits of Kang-Xing Jin, 10/25/2024
773. Deposition Transcripts and Exhibits of Margaret Stewart Gould, 10/21/2024
774. Deposition Transcripts and Exhibits of Mark Zuckerberg, 3/27/2025
775. Deposition Transcripts and Exhibits of Mark Zuckerberg, 3/28/2025
776. Deposition Transcripts and Exhibits of Michael 'Miki' Rothschild, 1/21/2025
777. Deposition Transcripts and Exhibits of Michael 'Miki' Rothschild, 1/22/2025
778. Deposition Transcripts and Exhibits of Shruti Bhutada, 11/18/2024
779. Deposition Transcripts and Exhibits of Shruti Bhutada, 11/19/2024
780. Deposition Transcripts and Exhibits of Vaishnavi Jayakumar, 1/30/2025
781. Deposition Transcripts and Exhibits of Vaishnavi Jayakumar, 1/30/2025
782. Deposition Transcripts and Exhibits of Wendy Gross, 1/28/2025
783. Deposition transcript and exhibits of Lotte Rubaek, 4/1/2025

**Expert Reports**

- 784. Expert Report of Adriana Galvan, Ph.D. dated 4/18/2025
- 785. Expert Report of Alan L. Berman, Ph.D. dated 4/18/2025
- 786. Expert Report of Anna Lembke, M.D. dated 4/18/2025
- 787. Expert Report of Benjamin Schneider, M.D. dated 4/18/2025
- 788. Expert Report of Craig Bryan, Psy.D. dated 4/18/2025
- 789. Expert Report of Daniel P. Keating, Ph.D. dated 4/18/2025
- 790. Expert Report of Dimitri Christakis, M.D., M.P.H. dated 4/18/2025
- 791. Expert Report of Doug Tucker, M.D. dated 4/18/2025
- 792. Expert Report of Dr. Ian Gotlib dated 4/18/2025
- 793. Expert Report of Dr. Jean M. Twenge, Ph.D. dated 4/18/2025
- 794. Expert Report of Dr. Kara Bagot, M.D. dated 4/18/2025
- 795. Expert Report of Dr. Ramin Mojtabai, Ph.D., MPH dated 4/18/2025
- 796. Expert Report of Dr. Robert Platt dated 4/18/2025
- 797. Expert Report of Dr. Scott Patten, MD, Ph.D. dated 4/18/2025
- 798. Expert Report of Dr. Sonia Lohiya Krishna, MD, FAPA, DFAACAP dated 4/18/2025
- 799. Expert Report of Dr. Stuart Murray, MSC, DClinPsych, Ph.D. dated 4/18/2025
- 800. Expert Report of Drew P. Cingel, Ph.D. dated 4/18/2025
- 801. Expert Report of Eva Telzer, Ph.D. dated 4/18/2025
- 802. Expert Report of Gary Goldfield, Ph.D. C. Psych. dated 4/18/2025
- 803. Expert Report of Jeffrey A. Hall, Ph.D. dated 4/18/2025
- 804. Expert Report of Jennifer Pfeifer, Ph.D. dated 4/18/2025
- 805. Expert Report of Keith Hampton, Ph.D. dated 4/18/2025
- 806. Expert Report of Kenneth T. Kishida, Ph.D. dated 4/18/2025
- 807. Expert Report of Matthew J. Shear, M.D., MPH dated 4/18/2025
- 808. Expert Report of Nicholas Allen, Ph.D. dated 4/18/2025
- 809. Expert Report of Randy Auerbach dated 4/18/2025
- 810. Expert Report of Robert D. Gibbons, Ph.D. dated 4/18/2025
- 811. Expert Report of Sarah Morsbach Honaker, Ph.D., HSPP, DBSM dated 4/18/2025
- 812. Expert Report of Terry Schwartz, M.D. dated 4/18/2025

**Production Bates Numbered Documents**

- 813. BEJAR0000004-BEJAR0000005
- 814. BEJAR0000051-BEJAR0000062
- 815. BEJAR0000165-BEJAR0000168
- 816. BEJAR0000305-BEJAR0000443
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- 818. BEJAR0002350
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- 823. BEJAR002591

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1795. TIKTOK3047MDL-056-00987598-TIKTOK3047MDL-056-00987608  
1796. TIKTOK3047MDL-058-LARK-00710555-TIKTOK3047MDL-058-LARK-00710564  
1797. TIKTOK3047MDL-060-01110007-TIKTOK3047MDL-060-01110041  
1798. TIKTOK3047MDL-060-01119793-TIKTOK3047MDL-060-01119795  
1799. TIKTOK3047MDL-060-01120905  
1800. TIKTOK3047MDL-060-01154780 - TIKTOK3047MDL-060-01154793  
1801. TIKTOK3047MDL-060-01155259-TIKTOK3047MDL-060-01155276  
1802. TIKTOK3047MDL-060-01155277 - TIKTOK3047MDL-060-01155279  
1803. TIKTOK3047MDL-060-01156119 - TIKTOK3047MDL-060-01156123  
1804. TIKTOK3047MDL-060-01157747 - TIKTOK3047MDL-060-01157754  
1805. TIKTOK3047MDL-060-01158658-TIKTOK3047MDL-060-01158678  
1806. TIKTOK3047MDL-060-01161309-TIKTOK3047MDL-060-01161594  
1807. TIKTOK3047MDL-060-01164280-TIKTOK3047MDL-060-01164305  
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1810. TIKTOK3047MDL-066-LARK-00961717 - TIKTOK3047MDL-066-LARK-00961724  
1811. TIKTOK3047MDL-066-LARK-00965597 - TIKTOK3047MDL-066-LARK-00965604  
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1814. TIKTOK3047MDL-067-LARK-01025176-TIKTOK3047MDL-067-LARK-01025181  
1815. TIKTOK3047MDL-069-01206536-TIKTOK3047MDL-069-01206545  
1816. TIKTOK3047MDL-078-LARK-01368033-TIKTOK3047MDL-078-LARK-01368036  
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1835. TIKTOK3047MDL-090-LARK-03554002 - TIKTOK3047MDL-090-LARK-03554010



- 1836. TIKTOK3047MDL-090-LARK-03669290 - TIKTOK3047MDL-090-LARK-03669296
- 1837. TIKTOK3047MDL-094-LARK-04022228-TIKTOK3047MDL-094-LARK-04022232
- 1838. TIKTOK3047MDL-099-LARK-04504706
- 1839. TIKTOK3047MDL-099-LARK-04519067
- 1840. TIKTOK3047MDL-099-LARK-04519067-TIKTOK3047MDL-099-LARK-04519099
- 1841. TIKTOK3047MDL-099-LARK-04759856
- 1842. TIKTOK3047MDL-111-LARK-05947738 - TIKTOK3047MDL-111-LARK-05947777
- 1843. TIKTOK3047MDL-115-04352891
- 1844. TIKTOK3047MDL-115-04352891-TIKTOK3047MDL-115-04352898
- 1845. TIKTOK3047MDL-11504353855
- 1846. TIKTOK3047MDL-117-04509578-TIKTOK3047MDL-117-04509603
- 1847. TIKTOK3047MDL-128-LARK-06606079
- 1848. TIKTOK3047MDL-131-LARK-06842264-TIKTOK3047MDL-131-LARK-06842269
- 1849. TIKTOK3047MDL-150-LARK-07275923 - TIKTOK3047MDL-150-LARK-07275929
- 1850. TIKTOK3047MDL-168-04784987 - TIKTOK3047MDL-168-04785000

*Deposition transcripts and exhibits listed herein exclude those subject to defense production  
clawbacks.*

# EXHIBIT D

## Reanalysis of Saiphoo and Vahedi's 2019 meta-analysis data limited to adolescents.

Original data from Figure 2 of the Saiphoo and Vahedi's paper ((Saiphoo, Alyssa N, and Zahra Vahedi. 2019. 'A meta-analytic review of the relationship between social media use and body image disturbance', *Computers in Human Behavior*, 101: 259-75):

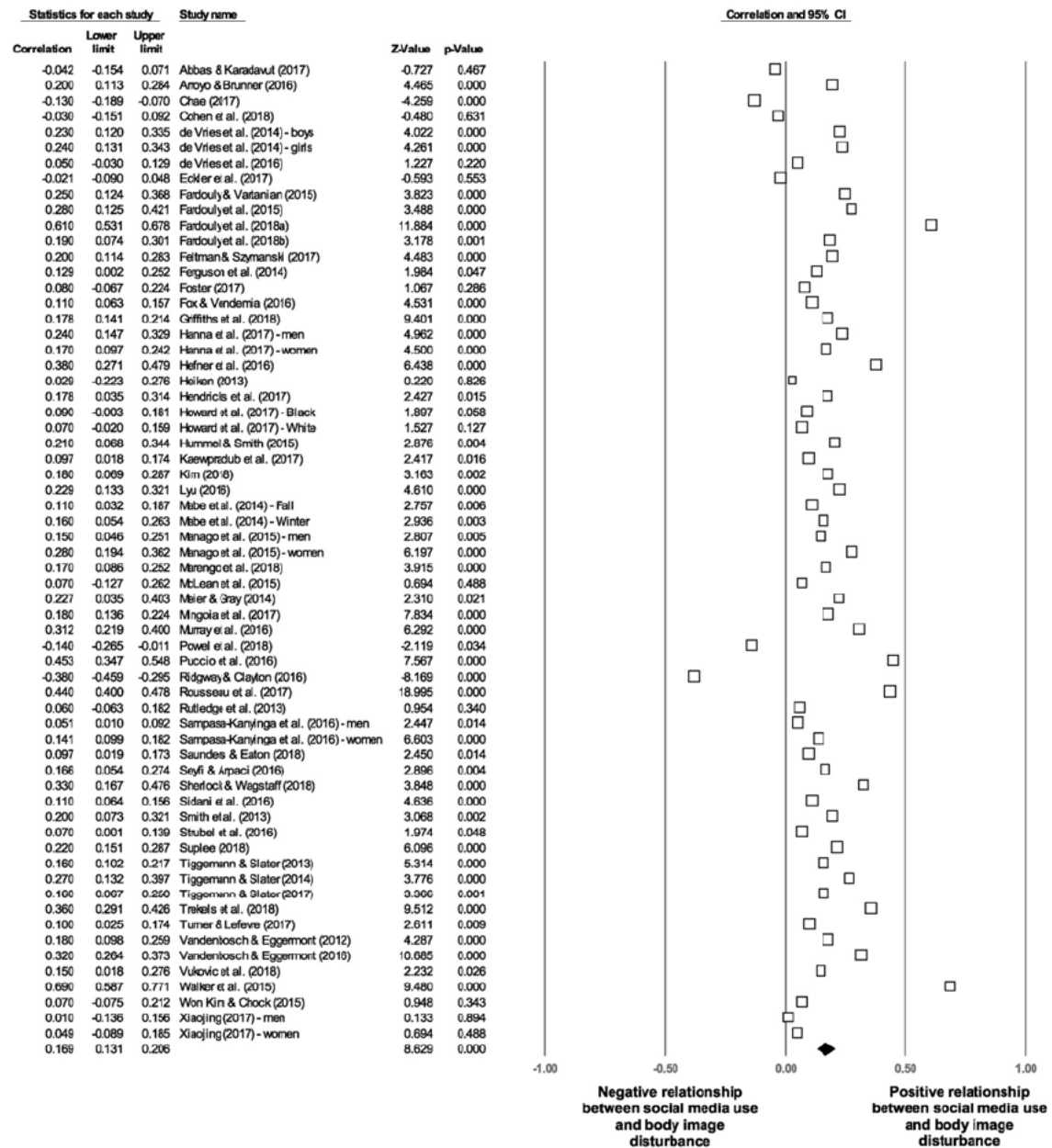


Fig. 2. Studies included in the current meta-analysis investigating the association between social media use and body image disturbance. Studies located to the right of the zero mark indicate a positive relationship between social media use and body image disturbance, whereas those included to the left of the zero mark indicate a negative association. The filled diamond represents the overall effect size. The summary effect size ( $r = .21$ ) is indicated by the filled diamond.

**Data extracted from 21 studies of adolescents:**

<b>First author's name and year</b>	<b>n</b>	<b>r</b>	<b>min</b>	<b>max</b>
De Vries 2014-Girls	306	.24	.13	.343
De Vries 2014-Boys	298	.23	.12	.335
De Vries 2016	604	.05	-.03	.129
Fardouly 2018	284	.61	.531	.678
Ferguson 2014	237	.129	.002	.252
Heiken 2013	62	.029	-.223	.276
Kaewpradub 2017	620	.097	.018	.174
Marengo 2018	523	.17	.086	.262
McLean 2015	101	.07	-.127	.262
Meier 2014	103	.227	.035	.403
Mingoia 2017	1856	.18	.136	.224
Rousseau 2017	1621	.44	.4	.478
Sampasa-Kanyinga-Males 2016	2301	.051	.01	.092
Sampasa-Kanyinga-Females 2016	2167	.141	.099	.182
Tiggemann 2013	1087	.16	.102	.217
Tiggemann 2014	189	.27	.132	.397
Tiggemann 2017	438	.16	.067	.25
Trekels 2018	640	.36	.291	.426
Vandenbosch 2012	558	.18	.098	.259
Vandenbosch 2016	1041	.32	.264	.373
Vukovic 2018	221	.15	.018	.276

**The Stata commands to run the analyses:**

```
meta set r min max, studylabel(name) studysize(n) civartolerance(1e-1)
```

```
meta summarize
```

```
meta forestplot _id n _plot, nonotes nullrefline(lcolor(black)) noohetstats noghetstats noosigtest  
noohomtest nogwhomtests nogbhomtests
```

**The Stata output:**

Meta-analysis setting information

Study information

No. of studies: 21

Study label: name

Study size: n

Effect size

Type: <generic>

Label: Effect size

Variable: r  
Precision  
Std. err.: \_meta\_se  
CI: [\_meta\_cil, \_meta\_ciu]  
CI level: 95%, controlled by level()  
User CI: [min, max]  
User CI level: 95%, controlled by civarlevel()

#### Model and method

Model: Random effects  
Method: REML

#### . meta summarize

Effect-size label: Effect size  
Effect size: r  
Std. err.: \_meta\_se  
Study label: name

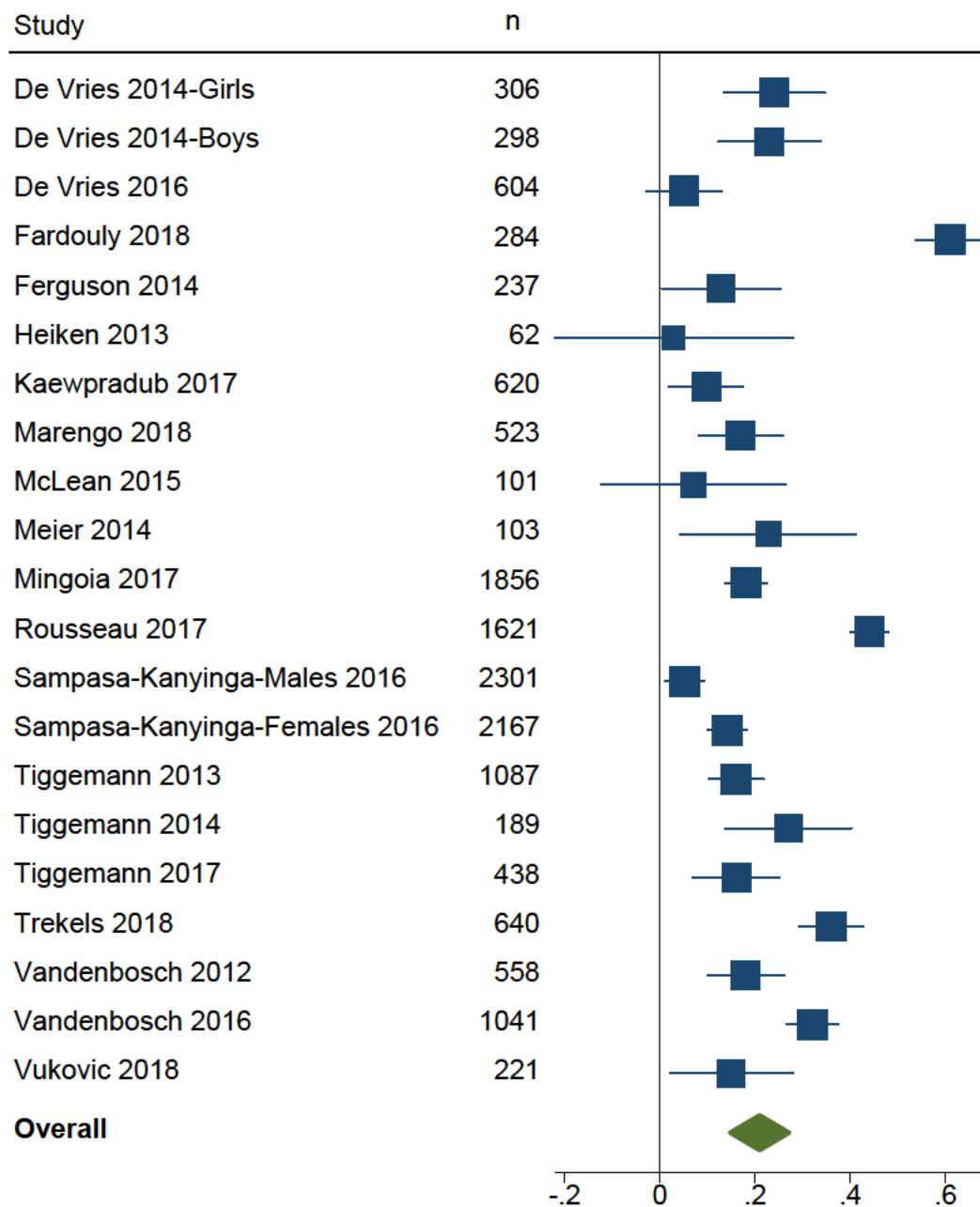
Meta-analysis summary  
Random-effects model  
Method: REML

Number of studies = 21  
Heterogeneity:  
tau2 = 0.0182  
I2 (%) = 93.54  
H2 = 15.49

Study	Effect size	[95% conf. interval]		% weight
De Vries 2014-Girls	0.240	0.133	0.346	4.72
De Vries 2014-Boys	0.230	0.122	0.338	4.71
De Vries 2016	0.050	-0.029	0.129	5.03
Fardouly 2018	0.610	0.537	0.683	5.09
Ferguson 2014	0.129	0.004	0.254	4.48
Heiken 2013	0.029	-0.220	0.278	2.90
Kaewpradub 2017	0.097	0.019	0.175	5.05
Marengo 2018	0.170	0.082	0.258	4.94
McLean 2015	0.070	-0.124	0.264	3.56
Meier 2014	0.227	0.043	0.411	3.70
Mingoia 2017	0.180	0.136	0.224	5.34
Rousseau 2017	0.440	0.401	0.479	5.37
Sampasa-Kanyinga-Males 2016	0.051	0.010	0.092	5.36
Sampasa-Kanyinga-Females 2016	0.141	0.100	0.183	5.36
Tiggemann 2013	0.160	0.102	0.217	5.24
Tiggemann 2014	0.270	0.138	0.403	4.39
Tiggemann 2017	0.160	0.068	0.251	4.90
Trekels 2018	0.360	0.293	0.428	5.15
Vandenbosch 2012	0.180	0.100	0.261	5.02
Vandenbosch 2016	0.320	0.265	0.374	5.26
Vukovic 2018	0.150	0.021	0.279	4.43
theta	0.209	0.147	0.271	

Test of theta = 0: z = 6.62  
Test of homogeneity: Q = chi2(20) = 385.52

Prob > |z| = 0.0000  
Prob > Q = 0.0000

**Forest plot produced by Stata:**



# EXHIBIT E

## Appendix E: Conversion of Hedges' g, Cohen's d, odds ratio, hazard ratio and Fisher's Z to Pearson r

In their classic text on meta-analysis, Borenstein and colleagues (Borenstein et al. 2009) describe a number of formulas for conversion among different effect sizes.

For converting Cohen's d to r, the formula is:

$$r = \frac{d}{\sqrt{d^2 + a}}$$

a in this formula is computed based on the number of participants in the two groups being compared (n1 and n2) and is equal to 4 when the groups compared have equal sample sizes. Borenstein and colleagues also states that "if n1 and n2 are not known precisely, use n1=n2, which will yield a=4."

In small samples, Cohen's d has a slight bias and overestimates the true value of effect size. Hedges has proposed a correction factor J to remove this bias (Borenstein et al., p. 27):

$$g = J \times d,$$

J is computed as follows:

$$J = 1 - \frac{3}{4df - 1}$$

where df is the number of participants in the study - 2. For larger studies and in the case of meta-analyses where the pooled sample sizes are in hundreds, Hedges' g is essentially the same as Cohen's d because the value of J is very close to 1. For example, in a study with a sample size of 100,

$$J = 1 - \frac{3}{(4 * 98) - 1} = 0.99$$

As such, we can use the above formula for converting Cohen's d to Pearson's r for converting Hedges' g to r as well.

For converting odds ratio (OR) to r, we will need to first convert odds ratio to Cohen's d using the formula below:

$$d = \text{LogOddsRatio} \times \frac{\sqrt{3}}{\pi},$$

Next, Cohen's d can be converted to r based on the formula described earlier. Of note, risk ratios for rare events (e.g., <10%) are equal to odds ratios. For example, for a sample of 100 the ratio of 7% over 5% produces a risk ratio of 1.4 equal to an odds ratio of 1.4:

$$RR = \frac{\frac{7}{100}}{\frac{5}{100}} = 1.4 \quad \text{and} \quad OR = \frac{\frac{7}{93}}{\frac{5}{95}} = 1.4$$

For rare events (<10%), hazard ratios (HR) are equal to odds ratios as well (Spruance et al. 2004) and I use the same formula for converting RR and HR to r that I use for converting OR to r.

Fisher Z is transformed to r using the Fisher's z-transformation:

$$r = \tanh(z)$$

tanh is the hyperbolic tangent function.

Below I show the computations for each conversion done in my report:

**p. 20:**

"The association was not uniform across age groups: the odds ratios were 2.50 (corresponding to an r=0.25) in students aged 11-14 and 1.45 (r=0.10) in those aged 15 and over."

For OR=2.50:

$$d = \log(2.50) \frac{\sqrt{3}}{3.14} \approx 0.505 \quad \text{and} \quad r = \frac{0.505}{\sqrt{0.505^2 + 4}} \approx 0.25$$

For OR=1.45:

$$d = \log(1.45) \frac{\sqrt{3}}{3.14} \approx 0.205 \quad \text{and} \quad r = \frac{0.205}{\sqrt{0.205^2 + 4}} \approx 0.10$$

**p. 32:**

"...females with high social media use (more than 1 hour daily) had greater odds of depressive symptoms (OR=2.15; 95% CI=1.58–2.91; corresponding to r=0.21, 95% CI=0.13, .28) and anxiety symptoms (OR=1.99; 95% CI=1.32–3.00; r=0.19, 95% CI=0.08, .29) compared to those who used social medial for a few minutes per day, while males with high social media use had 1.60 time greater odds of reporting depressive symptoms (95% CI=1.09–2.35; corresponding r=0.13, 95% CI=0.02, .23).

For OR=2.15

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \quad \text{and} \quad r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

For confidence intervals:

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

For OR=1.60

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

For confidence intervals:

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

For OR=2.15

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

For confidence intervals:

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

### p. 32

In longitudinal analysis among females, increased odds of depressive symptoms at an average age of 14.8 years was observed for high social media use in 1 previous wave (OR=1.76; 95% CI=1.11–2.78; corresponding to  $r=0.15$ , 95% CI=0.03, 0.27) or 2-3 prior waves (OR=2.06, 95% CI=1.27–3.37; corresponding to;  $r=0.20$ , 95% CI=0.07, 0.32)

For OR=1.76

$$d = \log(1.76) \frac{\sqrt{3}}{3.14} \approx 0.312 \text{ and } r = \frac{0.312}{\sqrt{0.312^2 + 4}} \approx 0.15$$

For confidence intervals:

$$d = \log(1.11) \frac{\sqrt{3}}{3.14} \approx 0.058 \text{ and } r = \frac{0.058}{\sqrt{0.058^2 + 4}} \approx 0.03$$

$$d = \log(2.78) \frac{\sqrt{3}}{3.14} \approx 0.564 \text{ and } r = \frac{0.564}{\sqrt{0.564^2 + 4}} \approx 0.27$$

For OR=2.06

$$d = \log(2.06) \frac{\sqrt{3}}{3.14} \approx 0.398 \text{ and } r = \frac{0.398}{\sqrt{0.398^2 + 4}} \approx 0.20$$

For confidence intervals:

$$d = \log(1.27) \frac{\sqrt{3}}{3.14} \approx 0.132 \text{ and } r = \frac{0.132}{\sqrt{0.132^2 + 4}} \approx 0.07$$

$$d = \log(3.37) \frac{\sqrt{3}}{3.14} \approx 0.670 \text{ and } r = \frac{0.670}{\sqrt{0.670^2 + 4}} \approx 0.32$$

**p. 37:**

“These authors identified 10 studies that examined the effect of experimental studies of social media restriction on depressive symptoms, stress, well-being and life satisfaction. They found a significant reduction in depressive symptoms as a result of social media restrictions (d= -0.29, 95% CI=-0.51, -0.07; p=0.01; equivalent r=-0.14)”

This conversion was done using this formula:

$$r = \frac{-0.29}{\sqrt{-0.29^2 + 4}} = \frac{-0.29}{2.02} \approx -0.14$$

**p. 37**

“The intervention was associated with an improved sense of well-being and reductions in depression and anxiety. However, the effect sizes were small (e.g., .09 standard deviation for depression and .10 for anxiety, corresponding to an r=0.05) (see Exhibit E).

Note that the “standard deviation” unit here is equal to Cohen’s d:

$$r = \frac{0.10}{\sqrt{0.10^2 + 4}} \approx \frac{0.09}{\sqrt{0.09^2 + 4}} \approx 0.05$$

**p. 37**

“A meta-analytic study of 18 studies found a risk ratio of 1.09 (95% CI=1.04-1.14) for a 10-µg/m<sup>3</sup> change in exposure to PM<sub>2.5</sub>, which means that a 10 µg increase in PM<sub>2.5</sub> particles (approximately equal to 1 standard deviation of the mean) increases the risk of lung cancer by 9%. This is a very small effect size (equivalent to r=0.03).”

This conversion was done via first converting risk ratio (RR) to Cohen’s d and then to r:

$$d = \log(1.09) \frac{\sqrt{3}}{3.14} \approx 0.049 \text{ and } r = \frac{0.049}{\sqrt{0.049^2 + 4}} \approx 0.03$$

**pp. 37-38**

“the hazard ratios for cancers of smokers vs. non-smokers were in the 1.5-1.6 range, corresponding to correlation coefficients of around r=0.11-0.13.”

This conversion was done via first converting hazard ratio (HR) to Cohen’s d and then to r:

$$d = \log(1.5) \frac{\sqrt{3}}{3.14} \approx 0.22 \text{ and } r = \frac{0.22}{\sqrt{0.22^2 + 4}} \approx 0.11$$

$$d = \log(1.6) \frac{\sqrt{3}}{3.14} \approx 0.26 \text{ and } r = \frac{0.26}{\sqrt{0.26^2 + 4}} \approx 0.13$$

**p. 39**

“While much of the literature reviewed by Nesi and colleagues focused on the association between specific content (e.g., cybervictimization or viewing material related to self-injurious thoughts or behaviors) and suicidal ideations and behaviors, four studies (n=21391) examined the association of problematic (i.e., addictive) social media use with suicidal ideations. The pooled effect size in these 4 studies was also on par with the associations noted for cybervictimization and for social media use involving posting or viewing material related to self-injurious thoughts or behavior (OR=2.81; equivalent r=0.27). (see Exhibit E).”

This conversion was done via first converting to Cohen’s d and then to r:

$$d = \log(2.81) \frac{\sqrt{3}}{3.14} = 0.570 \text{ and } r = \frac{0.570}{\sqrt{0.570^2 + 4}} \approx 0.27$$



**p. 39**

“The authors found a significant association between using more than 3 hours of social media per day and self-harm behavior (unadjusted odds ratio=2.74, equivalent  $r=0.27$ ; adjusted odds ratio=1.49, equivalent  $r=0.11$ ).”

This conversion was done via first converting to Cohen's  $d$  and then to  $r$ :

For OR=2.74:

$$d = \log(2.74) \frac{\sqrt{3}}{3.14} = 0.556 \text{ and } r = \frac{0.556}{\sqrt{0.556^2 + 4}} \approx 0.27$$

For OR=1.49:

$$d = \log(1.49) \frac{\sqrt{3}}{3.14} = 0.220 \text{ and } r = \frac{0.220}{\sqrt{0.220^2 + 4}} \approx 0.11$$

**p. 39**

“The analyses found that every additional hour of social media exposure was associated with a 40% higher odds of suicidal behavior (OR=1.40, equivalent  $r=0.09$ ), which was statistically significant. When the authors adjusted the analyses for a number of potential confounders, including baseline depression, the association was attenuated (adjusted OR=1.27, equivalent  $r=0.07$ )”

This conversion was done via first converting to Cohen's  $d$  and then to  $r$ :

For OR=1.40:

$$d = \log(1.40) \frac{\sqrt{3}}{3.14} = 0.185 \text{ and } r = \frac{0.185}{\sqrt{0.185^2 + 4}} \approx 0.09$$

For OR=1.27:

$$d = \log(1.27) \frac{\sqrt{3}}{3.14} = 0.132 \text{ and } r = \frac{0.132}{\sqrt{0.132^2 + 4}} \approx 0.07$$

**p. 38 footnote:**

“The odds ratio of 1.55 is based on transformation of  $r=0.12$ ”

Here the odds ratio was computed from  $r$  using the formula:

$$OR = \exp \left( \frac{r\pi\sqrt{4}}{\sqrt{3(1-r^2)}} \right)$$

Replacing r in the above formula we obtain:

$$OR = \exp \left( \frac{0.12 * \pi * \sqrt{4}}{\sqrt{3 * (1 - 0.12^2)}} \right) = 1.55$$

**p. 44**

“After removing outliers, the category 1 experiments produced a small but significant association (Hedge’s g= -0.28, 95% CI= -0.35, -0.20; equivalent r= -0.14, 95% CI= -0.17, -0.10) (see Exhibit E). A negative effect size in this context indicates poorer body image in the experimental group compared to the comparison group.”

$$r = \frac{-0.28}{\sqrt{-0.28^2 + 4}} \approx -0.14$$

For confidence intervals:

$$r = \frac{-0.35}{\sqrt{-0.35^2 + 4}} \approx -0.17 \text{ and } r = \frac{-0.20}{\sqrt{-0.20^2 + 4}} \approx -0.10$$

**p. 44**

“The effect size in the category 2 comparisons was smaller but still significant (Hedge’s g= -0.12, 95% CI= -0.20, -0.04; equivalent r= -0.06, 95% CI= -0.10, -0.02) (see Exhibit E).”

$$r = \frac{-0.12}{\sqrt{-0.12^2 + 4}} \approx -0.06$$

For confidence intervals:

$$r = \frac{-0.20}{\sqrt{-0.20^2 + 4}} \approx -0.10 \text{ and } r = \frac{-0.04}{\sqrt{-0.04^2 + 4}} \approx -0.02$$

**p. 44**

“The effect size for category 3 comparisons after the authors removed 2 outliers was in line with Category 1 studies (Hedge’s g= -0.29, 95% CI= -0.40, -0.18; equivalent r= -0.14, 95% CI= -0.20,

-0.09)(see Exhibit E). Of note, it is customary to remove outlier studies from meta-analyses as they indicate chance variations or variations due to unusual study sample or design.”

$$r = \frac{-0.29}{\sqrt{-0.29^2 + 4}} \approx -0.14$$

For confidence intervals:

$$r = \frac{-0.40}{\sqrt{-0.40^2 + 4}} \approx -0.20 \text{ and } r = \frac{-0.18}{\sqrt{-0.18^2 + 4}} \approx -0.09$$

#### p. 44

“The fourth meta-analysis in de Valle and colleagues’ report was a meta-analysis of 10 longitudinal studies. This meta-analysis also identified a small but significant negative effect of social media use on body image (Fisher’s Z= -0.08, 95% CI=-0.11, -0.06, equivalent r= -0.08, 95% CI= -0.11, -0.06) (see Exhibit E).”

$$\tanh(-0.08) = -0.08$$

For confidence intervals:

$$\tanh(-0.11) = -0.11 \text{ and } \tanh(-0.06) = -0.06$$

#### p. 45

“A significant association was found between exposure to non-celebrity accounts and negative body image outcomes (Hedge’s g= -0.20, 95% CI= -0.54, -0.10; equivalent r= -0.10, 95% CI= -0.26, -0.05) (see Exhibit E)”

$$r = \frac{-0.20}{\sqrt{-0.20^2 + 4}} \approx -0.14$$

For confidence intervals:

$$r = \frac{-0.54}{\sqrt{-0.54^2 + 4}} \approx -0.26 \text{ and } r = \frac{-0.10}{\sqrt{-0.10^2 + 4}} \approx -0.05$$

#### p. 65

“The intervention group experienced significant increases in both appearance (d=0.33, equivalent r=0.16) and weight esteem (d=0.27, equivalent r=0.13) from baseline to post-intervention.

$$r = \frac{0.33}{\sqrt{0.33^2 + 4}} \approx 0.16$$

$$r = \frac{0.27}{\sqrt{0.27^2 + 4}} \approx 0.13$$

**p. 65**

“The effect sizes for the association of social media use with both anxiety symptoms (odds ratio [OR]=1.55, 95% confidence interval [CI]=1.30–1.85 equivalent  $r=0.12$ , 95% CI=0.07, 0.28) and depressive symptoms (OR=1.43, 95% CI=1.14–1.80, equivalent  $r=0.10$ , 95% CI=0.04, 0.16) in the Lee and colleagues’ meta-analysis were in line with pre-COVID studies. The studies, however, were almost exclusively comprised of adults..”

Conversion for OR=1.55:

$$d = \log(1.55) \frac{\sqrt{3}}{3.14} = 0.242 \text{ and } r = \frac{0.242}{\sqrt{0.242^2 + 4}} \approx 0.12$$

For confidence intervals:

$$d = \log(1.30) \frac{\sqrt{3}}{3.14} = 0.145 \text{ and } r = \frac{0.145}{\sqrt{0.145^2 + 4}} \approx 0.07$$

$$d = \log(1.80) \frac{\sqrt{3}}{3.14} = 0.588 \text{ and } r = \frac{0.588}{\sqrt{0.588^2 + 4}} \approx 0.28$$

Conversion for OR=1.43

$$d = \log(1.43) \frac{\sqrt{3}}{3.14} = 0.197 \text{ and } r = \frac{0.197}{\sqrt{0.197^2 + 4}} \approx 0.10$$

For confidence intervals:

$$d = \log(1.14) \frac{\sqrt{3}}{3.14} = 0.07 \text{ and } r = \frac{0.07}{\sqrt{0.07^2 + 4}} \approx 0.04$$

$$d = \log(1.80) \frac{\sqrt{3}}{3.14} = 0.324 \text{ and } r = \frac{0.324}{\sqrt{0.324^2 + 4}} \approx 0.16$$

**p. 66**

“The overall effect size for exposure to social media feeds was  $g = -0.24$  (equivalent to  $r = 0.12$ ). Adjusting for publication bias reduced this effect to  $g = -0.18$  (equivalent  $r = -0.09$ ). The effect was largest for body image dissatisfaction ( $g = -0.31$ , equivalent  $r = -0.15$ ), followed by self-esteem and mental health outcomes (i.e., depressive and anxiety symptoms) ( $g = -0.21$ , equivalent  $r = 0.10$ )...”

For  $g = -0.24$ :

$$r = \frac{-0.24}{\sqrt{-0.24^2 + 4}} \approx -0.12$$

For  $g = -0.18$ :

$$r = \frac{-0.18}{\sqrt{-0.18^2 + 4}} \approx -0.09$$

For  $g = -0.31$

$$r = \frac{-0.31}{\sqrt{-0.31^2 + 4}} \approx -0.15$$

For  $g = -0.21$

$$r = \frac{-0.21}{\sqrt{-0.21^2 + 4}} \approx -0.10$$

**p. 70**

“They found a significant reduction in depressive symptoms as a result of social media restrictions ( $d = -0.29$ , 95% CI = -0.51, -0.07;  $p = 0.01$ ; equivalent  $r = -0.14$ , 95% CI = -0.25, -0.04)...”

$$r = \frac{-0.29}{\sqrt{-0.29^2 + 4}} \approx -0.14$$

For confidence interval:

$$r = \frac{-0.51}{\sqrt{-0.51^2 + 4}} \approx -0.25$$

$$r = \frac{-0.07}{\sqrt{-0.07^2 + 4}} \approx -0.04$$

These formulas and other effect size conversion formulas have been implemented in an online effect size converter app (<https://www.escal.site/>) by the MIT researcher Hause Lin and are freely available to public.

References:

- Borenstein, Michael, L.V. Hedges, J. P. Higgins, and H. R. Rothstein. 2009. *Introduction to meta-analysis* (John Wiley & Sons: Chichester, U.K.).
- Spruance, Spotswood L, Julia E Reid, Michael Grace, and Matthew Samore. 2004. 'Hazard ratio in clinical trials', *Antimicrobial agents and chemotherapy*, 48: 2787-92.